ENGINEERING NEWS

BY an undetected typographical error of a single letter (s) in our news column of last week, it was made to appear that Prof. GEORGE F. SWAIN, was employed as expert by the railroad company in the Bussey bridge case. The item should have read:

"Prof. GEORGE F. SWAIN, of the Massachusetts Institute of Technology, Mr. E. S. PHILBRICK, the *expert* (not "experts," as the types had it) employed by the railroad, and Mr. THOMAS DOANE, the expert employed by the Commission, should be giving their testimony, according to the announced programme."

The will of JAMES B. EADS, which has now been probated, seems to indicate that he has still about $1,000,000 clear to come to him from the Government for the South Pass jetty improvement. There will probably be a certain class of economists who will think this shows he was paid too much, but perhaps no money was ever better earned. He also bequeaths his stock in the ship railway enterprise in a way which indicates that he regarded it as a valuable thing, even after his death, and in the interest of science and engineering we hope it may prove to be, as it would certainly be a most interesting engineering enterprise. His death must be a great blow to its prospects.

Gov. HILL has withdrawn the unfit nomination for the responsible office of railroad commissioner, which we noted two weeks ago, to make two others; one being Mr. W. A. ARMSTRONG, editor of an Elmira agricultural paper, and Master of the State Farmer's Grange, and the other Mr. J. R. BUCKBEE, a "mechanical engineer" in the Boston & Albany shops, and Master Workman of the Iron-Workers Local Assembly of the Knights of Labor. Both are republicans. Should both be confirmed—which is not at all likely—there would be only one man on the commission of an intellectual training to qualify him to properly discharge the intricate and responsible duties of the office,—but the tricks of the demagogue with the presidential bee in his bonnet are past finding out.

UP to date the following brake companies have notified the Master Car Builders' Brake Committee that they have made arrangements for cars and engines, and will be present at the Burlington brake tests, beginning May 9, 1887:

EAMES Vacuum Brake Co., Boston, Mass.
CARPENTER Brake Co., Berlin, Germany.
WESTINGHOUSE Air Brake Co., Pittsburg, Pa.
CARD Electric Brake Co., Cincinnati, Ohio.
AMERICAN Brake Co., St. Louis, Mo.
HANSCOM Brake Co., San Francisco, Cal.

The PARKE Electric Brake Co., Chicago, Ill., and the ROTE Brake Co., Mansfield, O., have their brakes ready, but have not yet succeeded in arranging for cars. The committee will not debar them or any other company from the tests, providing they get their cars to Burlington by May 9, 1887. The tests will be a most interesting and important event.

Mr. W. RAMSAY is authority, says *Engineering*, for the statement that molten iron, seen during a casting of several tons, is transparent. He states that objects can be seen through it, partaking however of a yellow tinge. While this observation is interesting, we would, like our contemporary, prefer to hear other testimony on this subject.

THE latest reported trials with the 110½ ton Elswick gun at Woolwich are three shots fired on March 3, with the following results:—

	Projectile.	Powder.	Velocity.	Pressure.	Total Ene'gy
	lbs.	lbs.	ft. per sec.	tons.	ft. tons
No. 1.	1,800	850	2,142	19⅞	57,320
No. 2.	"	960	2,104	15·7	55,250
No. 3.	"	850	2,149	19·9	57,630

Shots 1 and 3 were made with German prismatic powder, and Shot No. 2 with Waltham Abbey powder. As compared with the Krupp 119 ton gun, the latter for a 2,028 lb. projectile and 1,900 ft. velocity ave 50,780 ft.-tons.

THE great B. & O. deal seems to grow more mixed every day. It is hard to even surmise what will be the final result, and the most plausible explanation of the long drawn out delay is that sugested by a clever Yonkers paper, that it is naturally hard work to turn a Garrettin to a seller.

NEW ORLEANS is looking forward to a "paving boom" according to the *Times Democrat*. This is coincident with a decided advance in real estate, and the pressing demand for better pavements.

THE hearing on the Bussey bridge disaster has terminated, but the finding is not yet announced. Five engineers in all testified as experts, Prof. VOSE, Assistant Civil Engineer MAULEY, Prof. SWAIN, of the Massachusetts Institute of Technology, Mr. S. S. PHILBRICK, of Boston, (expert on behalf of the company) and Mr. THOMAS DOANE (expert on behalf of the Commission). All have testified to their belief that the hangers were certainly the cause of the accident and that no other theory was admisible, and all but one have testified that they reached this conclusion immediately after the accident. The last hearing, on Monday, April 4, was chiefly devoted to an argument by the attorney of the company at the hearing. The main point of his argument, so far as can be judged by the brief report, was at the end; that "since the visible defects had not caused the accident, and the company had no means of knowing the concealed one, it should not be held responsible," a claim which the Commission will undoubtedly sit upon severely, since it would have been perfectly easy to discover old cracks at any time, had a competent bridge engineer been inspecting the bridge.

PROF. SWAIN'S testimony was directly to the point. He testified that "the hangers would probably sustain from 20,000 to 25,000 lbs. apiece if they were sound. That is the utmost limit. A less load would break them if applied a sufficient number of times." "If the design required excentric hangers, four or five times as much material should have been put in them." "Without adding any percentage, if the two hangers had been symmetrical (and both equally loaded) there would have been 8,000 to 9,000 lbs. per sq. in. strain on them." As they were not symmetrical, as they were not and hardly could be equally loaded, and as one hanger had been completely ruptured for a long time, it will be seen what a miracle it was that they held together as long as they did, the only possible explanation being that the little 5-in. I-beam underneath had been relieving them of nearly half of their strain for a long time. Prof. SWAIN likewise testified to both the hangers having old breaks in them, although the fact that all four of the fractures in the two hangers showed old cracks is not clearly brought out, if the abstract is correct. We presume likewise that the Professor is belied by the abstract of his testimony, which charges him with saying "the area of those hangers was such that if the hangers had not been excentric they would have been *amply strong*," since this is inconsistent with the rest of his testimony. A strain of 9,000 lbs. per sq. in. is not "amply strong" for a hanger, especially as the merest fraction of difference in their length (and they were roughly made) ensured that one hanger should carry all the load, or 18,000 lbs. per square inch *had it been symmetrical*.

The hangers were 1¾ x 1⅞ in. section when new, and the load on them when fractured something over 60,000 lbs., which gives somewhat higher figures than the Professor gives.

Mr. E. S. PHILBRICK was the fourth expert to testify. He was engaged on behalf of the railroad company. He had examined the old Bussey bridge (the wooden truss and iron truss combination) in 1872. He had never known another instance of parallel trusses of two distinct designs. Whether it was with his advice or consent that the same abnormal type of structure was continued by erecting the Hewins truss is not clear from the abstract of his evidence before us. We presume not, or he would hardly have been asked to testify as expert again. He likewise, like all the experts before him, testified that the hangers were undoubtedly the cause of the disaster and had been gradually breaking for years, and that he had made up his mind to this effect the day after the fall of the bridge.

Mr. THOS. DOANE, the fifth expert, engaged on behalf of the Railroad Commission, likewise testified that the breaks in the hangers "were mostly old ones," that they broke under the weight of the locomotive, and "were the sole cause of the accident." Alone among the experts who have so far testified, he did not testify that he had formed this opinion immediately after the accident, although he does not appear to have ever entertained any other.

AS will be seen from the notice in another column Messrs. CHARLES KELLOGG and THOMAS C. CLARKE have withdrawn from their partnership connection with the Union Bridge Co., the partnership having terminated by limitation. The firm will hereafter consist of C. S. MAURICE, CHARLES MACDONALD, GEO. S. FIELD and EDMUND HAYES.

THE beneficial effect of taking out the coupling slack in the train of 30 cars recently tested on the Chicago, Burlington & Quincy Railroad, is described to us by an officer of the road, who looks at the matter in a strictly impartial and scientific manner, as having been "all that could have been hoped for by the most sanguine." He says:

"Imagine the *chucking* and *clucking* you would get in a 30-car link and pin, passenger trains running over sags, dips and hollows, such as we have in Iowa and how completely the matter would be remedied by doing away with the link and pin, and substituting the MILLER hook. This will give you a *fair idea* of what the wedges did."

The letter in another column gives a fair idea of the details of the trip, the contrast having been so striking that it hardly seems worth while to reproduce the details of the shocks. The motion of the "slidometer" (a mere iron disk sliding in a pine trough) was from 3 to 6 in. in a number of ordinary working stops with loose couplings, whereas 1 in. was the greatest corresponding movement after the slack had been taken out with 3-in. wedges. It will not be surprising if these results should lead to some early and definite action on the part of some of our great lines, tending to a solution of the car coupler question.

ENGLISH reports have it that the Chinese Viceroy, LI HUNG CHANG, has sanctioned the construction of an important railway line connecting Lotia Taku and Tientsin. To the disappointment of foreign promoters, the building is to be entrusted to Chinese labor and enterprise; but it is hoped that the seed thus to be sown will yet be reaped in good part by western nations.

IN connection with Chinese railway-building, a Belgian journal claims that a strong syndicate of Belgian and English capitalists has been formed for building 1,500 miles of railway. They propose to place in the hands of the Chinese government the sum of $160,000,000 to be repaid in ten annual instalments, and doubt not but what "the proposal will be accepted." The line contemplated includes one of 800 miles from Nanking along the great canal to Pekin, and another of 700 miles from Canton to Hanoi. The capital to be invested and the lines to be built are apparently fixed quantities, whatever the acceptance of the proposal may be.

ACCORDING to late accounts, Shaft 15 on Section 7 of the New Croton Aqueduct, has again made an advance on the fast tunnel-driving record. Foreman JOHN. R. BARRON having made the "biggest" monthly run (326 ft. in 25 days) in last January now caps this with the greatest weekly progress on record in this country. His best week's run in January was 90 ft., but from Feb. 19 to Feb. 26, he has made 102.1 ft. in the south heading of Shaft 15 with three Rand Slugger drills in 13 shifts. The ordinary gang did the work with rackarock powder as the explosive. The heading was 9×17 ft. in a hard, quartzose gneiss. WM. JOHNS and PATRICK HALEY were the heading bosses. An essential feature worthy of note in this really remarkable progress, is that no extra labor was enlisted and the work was done very cheaply; a little more energy and intelligent handling of the labor and machines used, account for it; and the credit for this is mainly due to the experience of Messrs. PAIGE, CAREY & Co., who have recently been put in charge of this section.

The New Water-Works at Bridgeport, Conn.

Bridgeport, has been supplied with water for the last thirty years, by the Bridgeport Hydraulic Co. a private corporation that took its water from the Pequonnock river.

The quantity and quality of the water supplied has always been a subject of great complaint, and various efforts have been made at different times by the citizens to compel the company to furnish a better supply, but without success. In the summer of 1885, the discovery of numerous nuisances upon the banks of the Pequonnock river, and tributary streams, and the condemnation of the water by the Chairman of the State Board of Health wrought up public opinion to a high state of indignation. As a result of this, several of the prominent citizens of the place, conceived the idea of forming a new company as a means of relief. During the following autumn surveys were very quietly made, with a view of obtaining water from Mill river, a fine clear stream in the adjoining towns of Fairfield and Easton. These preliminary surveys having demonstrated the feasibility of the project, application was made to the Legislature in Jan., 1886, for a charter for a company to be known as the Citizens Water Company. This was strongly opposed by the old company, but the new company backed by the public sentiment of the community, the town and city boards of health, and by the city in its corporate capacity, succeeded in obtaining a charter, there being but one dissenting vote in both branches of the Legislature. The charter received the Governor's signature in March, 1886, and the company was immediately organized, the requisite amount of stock having been taken within a week. Immediately steps were taken to perfect the plans for constructing the works.

Two projects were discussed. First: The construction of a dam across the stream at a point some five and one-quarter miles northwest of the limits of the city, thus forming a large reservoir, and bringing the water by gravity. Second: To take the water from the stream at a point some three miles lower down, pumping the water to a reservoir upon a high hill near the river and from thence bringing it to the city by gravity. The first project required the construction of a high dam, about five and one-quarter miles of main-pipe line, and owing to the stream lying in a deep valley separated from the city by a high ridge, the construction of a tunnel or a very deep open cut.

The second project required the construction of a dam across the stream, a large distribution reservoir, about four miles of main-pipe, and the erection of pumping engines. The relative advantages of cost and greater security, as well as greater head, were found to lie with the first project and that was, therefore, adopted and the works have been carried out in accordance with it.

For the dam a solid masonry structure was decided upon. The design is of the Kranz type and a cross-section is shown in Fig. 1. The length of the dam from end to end of guard wall is 635 ft. Length at bottom of stream about 50 ft. The overflow is placed at the west end of dam, 5 ft. below the top of guard wall, and is 30 ft. in length. The dam is furnished with a sluice way, 3 ft. 4 in. square in the clear, and waste gate operated by a worm gear. Fig. 2 shows a section through the gate chamber, and Fig. 3, plan of same.

The back of the dam forms one side of the gate chamber, the other three sides are formed by rubble masonry walls, 7 ft. thick at the base and battering to 3 ft. at top. Within the rubble masonry there is a brick lining, 1 ft. thick laid in cement mortar. The chamber is divided into two sections by brick walls, extending from the two opposite sides 2 ft. 10 in. toward the center, and between these fish screens of fine wire in wooden frames are placed, the frames sliding in iron castings, which are fastened to the brick-work by bolts passing through into the stone-work.

The gate chamber is furnished with three openings, and independent gates operated by worm gears to allow of the admission of water at different elevations.

The dam is of good rubble masonry laid in Rosendale cement. Mortar, two parts of sand to one part of cement. The foundation of the dam is of solid rock throughout the whole length. An earth embankment of 50 ft. base at the lowest point extending up to within about 10 ft. of the overflow will be placed upon the upstream side of the dam upon the completion of the masonry. The area flooded will be from 50 to 60 acres, and the volume impounded approximately 240,000,000 galls.

The main pipe line consists of a 30-inch cast-iron main from the dam to a point 1200 ft. below the tunnel, a distance of 2.58 miles, where it reduces to a 24-inch pipe extending thence a distance of 2.58 miles to the junction of North and Clinton avenues in the outskirts of the city, the first point where distribution pipes are taken off. A 24-in. main has also been laid for one-half a mile down Clinton avenue; supplying several 6-in. 8-in. and 12-in. distribution, and reducing at the junction of Fairfield avenue to a 20-in. main, extending to the center of the business portion of the city about one mile distant. The main pipe line is supplied with air valves at summits and blow-offs at depressions, and with gates at each end of the tunnel.

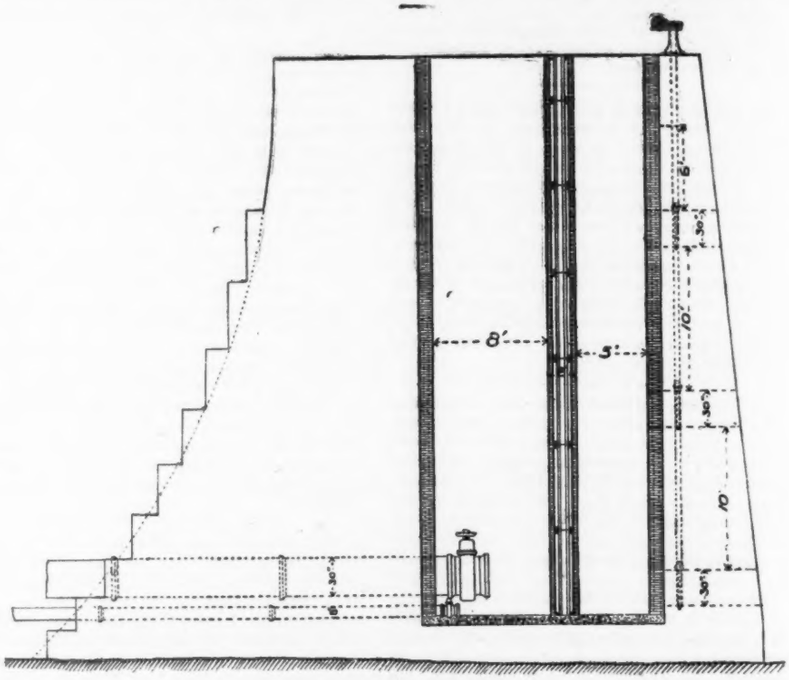


Fig. 2. Section Through Gate-Ch mber.

The tunnel is through solid rock 2,700 feet long and 6 ft. × 6 ft. in section. It has an ascending grade of 0.2 of a foot per 100 ft. from each end to the summit. The average depth below the surface is about 50 ft., the greatest depth being 61 ft.

Fig. 4 shows a profile of the ridge with details of the tunnel.

The tunnel passes under the Easton turnpike following the course of the road for some distance, and also under several dwellings rendering an open cut much more expensive.

The character of the rock passed through is a very hard compact gneiss, intersected by numerous seams or beds of solid quartz and occasional beds of mica schist and hornblende rock. Machine drilling by compressed air is employed, Rand drills of the "Little Giant" pattern being used. "Slugger" drills were tried, but the smallness of the heading prevented their successful working, there not being sufficient room to properly turn the drill. The center cut system of blasting is used, the holes being about 6 ft. deep. The tunnel is driven from both ends without shafts, the north heading being started in the latter part of July, 1886, and the south heading early in August. Two drills were used in each heading up to Jan. 1, 1887, the headings then being 6 ft. × 8 in., and 12 to 16 holes were put down. Since Jan. 1, one drill to a heading, has been used the heading being 6 ft. × 6 ft., and from 8 to 10 holes are drilled. Rack-a-rock is used in blasting. In some cases a small quantity of dynamite is used in the bottom of the holes, the remainder of the charge being rack-a-rock. The following table gives the monthly progress in both headings.

The progress is dependent upon the time required to remove the muck or blasted rock, the heading being so small that only three muckers can work to advantage. The drilling and blasting can be carried on much faster than the muck is removed, even

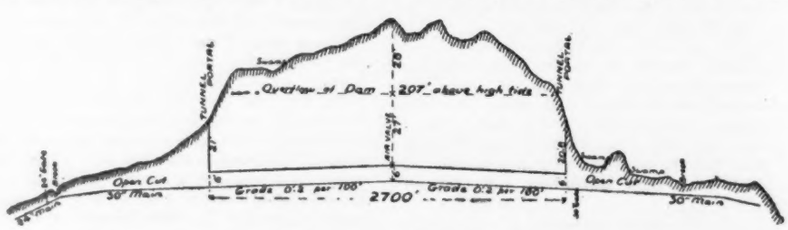


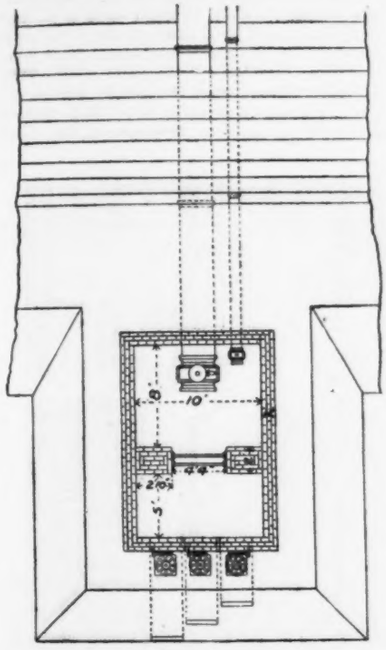
Fig. 4. Profile of Tunnel.

Table of Monthly Progress; Citizens Water Co's. Tunnel.

MONTH.	NORTH HEADING.	SOUTH HEADING.
	Feet.	Feet.
July, 1886,	35	
August, "	115	120.5
September, "	156.75	179.5
October, "	177 75	179 5
November, "	150.5	124.5
December, "	140	128.5
January, 1887,	121.5	76
February, "	96.5	82.5
March, "	68 ¾ of m'nth	69 ¾ of m'nth
Total,.....	1059	960

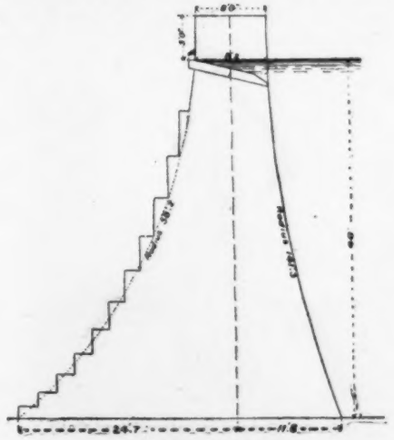
Total, both Headings..... 2,019 feet.

with one drill to a heading. As shown by the table the North heading has been driven a distance of 1,059 ft. and the South heading a distance of 960 ft., leaving 681 ft. to complete the work. The 30-in. main will be laid through the tunnel upon its com-



Plan of Gate Chamber.

pletion. With the exception of the tunnel and the laying of the main through it this portion of the work is nearly completed. Work upon the dam, which was stopped Dec. 1, will soon be resumed and it is expected that it will be finished in about one month. The distribution pipes in the city yet remain to be laid, work upon them having also ceased



Cross-Section of Dam.

Dec. 1. Messrs. HULL & PALMER, of Bridgeport, are the engineers, and Messrs. COLE & GILLETTE, of Boston, Mass., and Norfolk, Virginia, are the contractors for the entire work, Messrs. O. HEHIR & BROOKE, of New York, being sub-contractors for the construction of the dam.

The directors of the company are Dr. J. DE VERE WARNER, of Bridgeport; L. C. WARNER, of New York; P. T. BARNUM, JAMES STAPLES, H. N. BEARDSLEY, A. J. BEARDSLEY and D. T. HOLLESTER, all of Bridgeport. Dr. WARNER is President, and JAMES STAPLES, Secretary and Treasurer of the company.

Dry Docks.—The Secretary of the Navy has approved the sites selected by the committee; they will be located at the New York and Norfolk navy yards and will be built by contract on the general plan of the Simpson dry docks. They will be of timber, 485 ft. long, 125 ft. wide at top, and 60 ft. wide at bottom. The amount available for their construction is $1,100,000.

The Sanitary Condition of Soil Under Cities.

Dr. H. MARIE DAVY, in *Le Genie Civil*, writes upon the sanitary condition of the soil underlying cities, and in so doing points out some striking facts that are very generally overlooked. He says, in substance, as follows:

The underground waters of our cities are very generally, like the soil itself, contaminated by infiltration from the streets, houses, drains, etc., and this pollution is thus carried far from its point of origin. But with this pollution there is an inverse action of purification going on in the soil itself which must be taken into careful account in estimating total effect.

Very often the impurities of a certain water are of a mineral character due to the composition of the strata through which it passes. For example, the water of the Parisian basin proper is hard and selenitic on account of the sulphate of lime present in the soil, and the debris of buildings accumulated near the surface. This water is often disagreeable to the taste, and is rarely applicable to either industrial or domestic use; its influence upon the general health is much contested, particularly as to the proportion of sulphate of lime which may be considered harmful. On the other hand its action is efficient and prompt in dealing with human waste, and the germs that often pollute it.

In these subterranean streams this waste matter generally undergoes such a transformation that it would probably escape research, were it not for certain residual elements; chlorine and azote seem to be the best adapted to the betrayal of organic alteration in such soil and water. The chlorine derived from alkaline chlorides is not volatile and has very little affinity for the soil; that portion not taken up by plants and removed with their products passes, therefore, directly into the underground waters. Unhappily its proportion changes with the origin of the material which encloses it, and it enters into the composition of widely distributed natural products. Its presence in any water is thus far from being proportional to the quantity of organic matter introduced into this water.

In the pure water of Paris, the proportion of chlorine varies from 5 to 7 grammes per cubic metre. The Seine contains from 6 to 10 grammes; the Ourcq at La Villette is more variable, in general, the proportion is about 10 grammes per cubic metre. In the sewage, as it arrives at Gennevilliers, and when the salt used on the streets in winter is eliminated, the dosage of chlorine amounts to 75 to 80 grammes per metre.

In the well water of Paris, the proportion is very unequal between different wells and even in the same well at different times of the year. The mean of ten monthly analyses made in 1885, showed 40 grammes for a well in the Rue de Flandre, to 170 grammes in another well on the Rue Guénégand; the mean of all these wells was 106 grammes per cubic metre. This total mean seemed to be a little less in the beginning of 1886, perhaps simply an effect of meteorological conditions. In June, 1886, the figures for a well on the Rue de Brosse, and another on the Rue Saint Severin oscillated between 30 and 234 grammes per cubic metre.

While these large figures may be charged to the local injection of industrial chlorides, this can not be true for all. The discrepancy in amounts is found at great distances from Paris where there is no chance of industrial contamination. At Chateau-Renard (Loiret) the wells give 62 grammes; at Vitray-sous-Brezolles, it is 94 grammes; and both wells are deep and provided with pumps. In the village of Dornecy, wells tapping the same underground water-bearing stratum varied from 10 to 420 grammes per cubic metre; but the water from the well giving the last named figure was brown in color, and showed to the eye evident traces of fouling from the stable-yards near by.

Organic matter mixed with water is always more or less azotic. This azote rarely shows itself in its primitive state, but by fermentation has generally passed into ammonia, or by nitrification into nitrates; it must therefore be looked for in one of these three states.

The mean of analyses of the sewage at Gennevilliers gives as a total 32 grammes of azote per cubic metre; and in the drains at Asnieres we find 25 grammes. It is in the state of nitrates that this element especially exists in the well water of Paris. In this state the mean quantity varies; analyses show averages from 6½ to 66.7 grammes in various wells. Individual variations are still more marked; in Aug., 1886, one well gave 145 grammes per cu. metre. That this condition of affairs is not confined to Paris and thickly populated districts, is shown by the fact that remote country wells have yielded 28 grammes.

This nitrous azote renders the water containing it very fertilizing for plant life when the soil likewise contains a sufficient quantity of phosphoric acid. Land irrigated from the well at Chateau-Renard (which contains 27.9 grammes of azote) at the rate of 10,000 cu. metres per hectare furnishes to this area 279 kilogr. of azote, or more than a fertilizer of high grade.

There is above all things one property of the soil that is most beneficial to us, thanks to certain of those microbes which we fear so much to day. The soil seems to hasten the burning up of these impurities and renders them inoffensive; consuming in this operation, through these microbes, the oxygen of the air that earth and its waters nearly always contains. This combustion transforms the carbon in the objectionable matter into carbonic acid, its hydrogen into water and its azote into nitric acid; all of which products are taken up by plants and transformed by them into new organic products.

The determination of the quantity of organic matter actually dissolved in any water may exhibit to us the present state of that water, but will tell us nothing as to the original quantity which polluted it. Taking the ammoniacal azote first, the quantity found is simply the difference between the original volume of the organic elements and the combustion to which this has been submitted. There are then two orders of events essentially distinct, notwithstanding the relation which may be established between them in cities and villages. In Paris, especially in the more dense centers of population, the conditions are very favorable to the volume of organic matter supplied; combustion on the other hand is here retarded by the relatively small quantity of air contained in the soil and water. The oxidizable character of the residual organic matter is notable, although it is much less than the total of chlorine and azote would lead us to expect. In 1885, this oxidizable quantity varied from 3.3 to 14.7 grammes, with a general mean of 7.6 grammes, per cu. metre; while it was only 1.3 grammes for the water from Asnieres, derived mainly from the infiltration of sewage water supplying an irrigation district.

In the same time that the ammoniacal azote from the water of ten Paris wells varied from 0.6 to 7.4 grammes, with a mean of 2.7 grammes, this same matter only existed in the Asnieres water to the extent of 0.7 grammes. And when the mean of total azote from the ten Paris wells had reached 37.7 this was then only 23.6 grammes for Asnieres.

The result of these figures would show that the water from the Paris subsoil receives proportionately more organic matter than even the water in its sewers. The fundamental difference between them, however, proves the effect upon such organic matter of the oxygen in the air, whether this air is mingled with the water or fills the interstices of the soil. This difference is greater as the action of the air is more or less interfered with or obstructed.

It would seem that the rational means for making more healthy the soil under our cities and the waters which traverse this soil may be included under two distinct heads, diminish the volume of organic matter to be nitrified, and make this nitrification more active.

In a flat country this double end is always easily attained; the volume of fertilizing elements or manure supplied each year is far from touching the limits of the nitrifying power of the soil, even when the manure is applied at short intervals. The water derived from such a district is nearly always pure, unless it is effected by mineral components in the soil. The analyses made even to the present day in the plain of Gennevilliers demonstrate the fact that this deposit of organic matter may be extended to an enormous proportion without this nitrification ceasing to be complete. The residual waters flowing off here contain only the products derived from this combustion and not utilized by the plants cultivated.

In the built-up soil of a city, the slow combustion

of organic matter present in exaggerated volume, is due to the lack of air. Here it is necessary to first reduce the supply of organic matter to the soil; this can be done by the absolute suppressal of all permeable receptacles of such matter or conduits of a similar character, and the more abundant supply of water to dwellings and the frequent washing of houses and streets; and finally by providing an easy and rapid discharge for this waste water, and the waste matter of life generally before fermentation can set in and through perfectly tight sewers such as now exist in Paris. All detritus too that ought to nitrify should be methodically distributed over a sufficient area of soil.

While this second condition may appear to conflict with the first, we ought also to increase as much as possible the nitrifying power of the soil. To make the soil as impermeable as possible to the surface-water in cities is to also make it impermeable to air itself. But there still remain the planted and sodded areas of public squares, etc. The second condition will be the less difficult to realize as the proportion between these untrodden areas and the areas that should be tight, owing to the traffic upon them, becomes greater; in affect we should extend the one and make the other still more impermeable if we cannot reduce its area.

While the discussion of the microscopic organisms mingled with all water is left by the author for another paper, he still states that the number of such organisms present in any water is generally less as the nitrification by the soil is more complete and the distance traversed through an aerated soil the greater.

The Forth Bridge.

(See Full Page Illustration.)

The full page illustration, from *Engineering*, shows very graphically the late stages of erection on the south main pier of the Forth Bridge. The northern pier is a little more advanced and the Inch Garvie, or central pier, is making rapid progress in the same direction.

The illustration shows the working platform above, supported by two pairs of latticed girders running parallel to the axis of the bridge, and resting in turn upon built beams placed at right-angles to this axis and passing through the columns at openings made by temporarily omitting plates. These built beams are supported in the main columns upon a pair of deep plated frames, one above the other, and provided with hydraulic jacks for lifting them; when required these frames are held in a fixed position by pins passing through their wings and the ribs of the column.

The hydraulic jack is located between the bottom of the transverse beam and the top of the lower frame, and when the power is applied the jack lifts the girder and the upper frame with it; when opposite a second series of pin holes the upper frame is made fast to the column-ribs by inserting the pins, and the lower frame is hauled up and made fast for another lift. The working platform is thus lifted about 16 ft. for each further set of plates to be added.

The riveting cages, seen near the top of the main tubes, are made of angle-irons and plates and are covered on the outside with wire-netting as a protection for the workmen. The riveting of the plates is done by hydraulic power; the ram abutting against a pivoted girder supported at the center of main column between two diaphragms, and acting against a second vertical column attached to the outer cage. The method of attaching and handling these riveting cages is not described by our contemporary. The entire erecting plant was designed by Mr. William Arrol, and in its magnitude and detail forms a fit adjunct to this boldest of all bridge structures.

Praiseworthy Precaution.

Chairman (of the Board)—The master mechanic reports the Deep river bridge unsafe.

Directors (without a dissenting voice)—Give it a new coat of pea geeen paint.—New York *Sun*.

Is investigating the causes of the dreadful accident on the Boston and Providence Road the committee should take into serious consideration in all its ramifications the confession of Rev. Joseph Cook that several years ago he wrote some poetry "on the very spot where the accident happened."—*Exchange*.

The Water-Service of Paris.

From *La Nature* we abstract the following short description of the water-distribution of Paris:—This distribution is divided into two distinct systems; one brings water from the Seine for street service and other use not domestic, and the second system conveying potable water from the Dhuis and Vanne rivers. The latter supply is pure and limpid but slightly calcareous.

The water brought into Paris by conduits, is stored in seventeen covered reservoirs of a total capacity of 11,655,600 cu. ft., and located at elevations above the Seine, of from 150 to 440 ft. The water from the Seine, by the Ourcq canal, is pumped up into the reservoirs by six pumping stations. Water is likewise taken from the Marne, and from artesian wells for the public service.

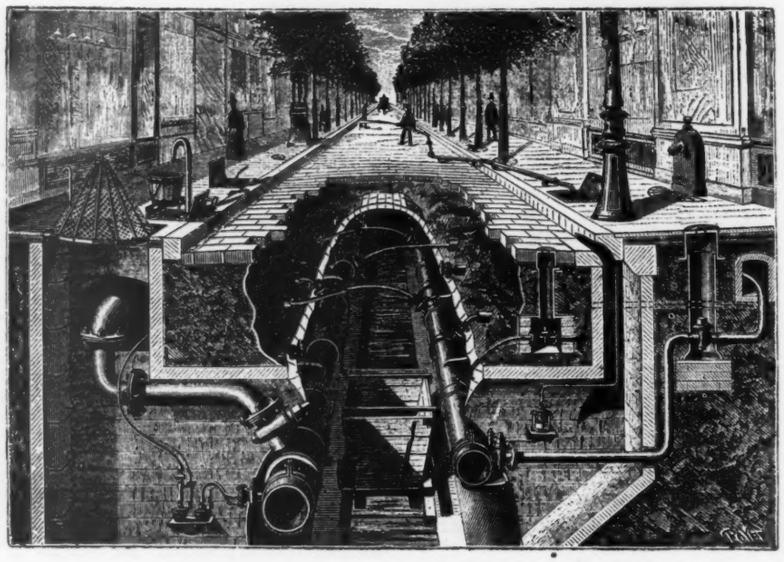


Fig. 1.—Arrangement of Water Mains, etc., in Paris.

The quantity of water daily introduced into Paris is as follows:—

Spring water (Vanne and Dhuis)	4,205,000 cu. ft.
Canal water (Ourcq)	3,880,000 "
Seine water	6,000,000 "
Marne water	2,900,000 "
Total	16,985,000 cu. ft.

This is about 48 galls., (about 14 galls. of potable water) per head on the average. The present attempt to introduce modern water-closets into Parisian dwellings will greatly increase the present demand for water, if at all successful; and to meet this increase new sources of supply have been already secured, and it is believed that in 1889, Paris will have an average of 66 galls. per head for 2,250,000 inhabitants.

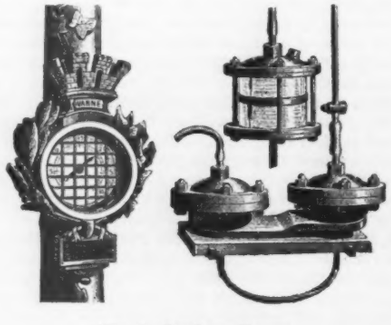


Fig. 2.—Leakage Gauge.

The two distribution systems, while intended to convey independent supplies are connected nevertheless so that in an emergency one can supplement the other—with a very undesirable mixture of the fluids, an occurrence fortunately very rare. The mains are usually placed in the great sewers of Paris, as shown in the illustration. This cut shows the various connections and fixtures; the peculiar shaped box on the pavement, on the right, is a fire-hydrant with its pave stop-cock; the pyramidal safety-cover over the sewer manhole, on the left, weighs only 13 lbs. The street sprinkler at work is using a device that would admit of application in this country. This sprinkler is made of about eight 10 ft. lengths of pipe connected by a short section of rubber hose clamped to the pipes, and supported at each joint on a 2-wheeled carriage with a central pivot. This arrangement allows great freedom of motion in the user; commands a radius of 80 or 100 ft. from each pave-cock; is cheap in construction, and there is very little to wear out in use as compared with a rubber hose. They are used as a substitute for watering-carts in the more narrow streets, parks, etc., one man having charge of a certain area and drags his sprinkler after him on its wheels from one pave-cock to another.

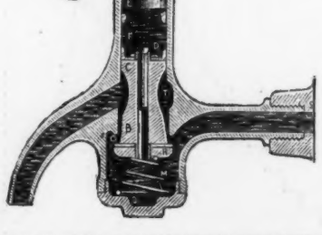


Fig. 3.—Chameroy Intermittent Cock.

The distribution mains of Paris are said to have a length of 1,020 miles. With the mixture of systems in Paris, it is absolutely necessary to keep a sharp lookout for leakage or any disarrangement of connections. To this end, some 3½ years ago, manometer stations were established. These comprise a pressure gauge affixed to the lamp post and connecting in the sewer with an apparatus consisting of two superimposed cylinders of thick glass separated by a rubber diaphragm as shown, for both gauges in Fig. 2. This diaphragm forms a passive partition between the columns of water in the main and the tube ascending to the lamp-post gauge, and is intended to remain horizontal under normal conditions; any leakage or other cause of disturbance tells its story through this diaphragm on the dial above, which also gives the source of water, number of station, diameter of main, elevations of main and ground and the axis of relative pressure.

Another Paris device that would probably be objected to here, but is a check on the waste of water, is one intended to prevent a *continuous* flow from house fixtures. This is shown in Fig. 3,and is known as the Chameroy Intermittent Cock. This works as follows: When the handle is pushed downward, the cam through the stem *G* forces down the piston *E*, and this last acting through the water in *F*, pushes down the lower piston *C* and allows the water to escape at the annular orifice *O*. But the spring below causes the check *B* to slowly rise and thus gradually shut off the flow. As a consequence consumers *can* get only from 14 to 18 pints of water (according to a fixed adjustment) at *each* depression of the handle, but may shut it off at any quantity by raising this handle. The awkward feature is that in case of any leakage, the chambers *M* and *F* must be artificially charged by unscrewing the cap *H*.

The Bursting of a Dam at Ingersoll, Canada.

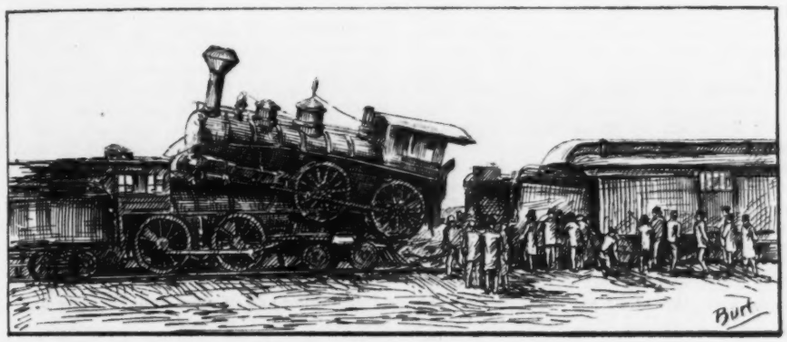
Our illustration shows the site of the dam carried away early in the morning of April 5, at King's Mill near Ingersoll, Canada, the disaster being attended with the loss of five lives, and very considerable property.

This structure was built about 29 years ago, and was simply an earthen bank, with a timber crib overflow in the central portion, from which water was carried by a circular iron flume to the mill near by. The dam was evidently a piece of faulty construction originally, and according to local accounts had not received any marked repairs since the date of its building. At various times water has been noticed leaking through it to a very considerable extent, and the proprietor had been very lately warned of its dangerous condition.

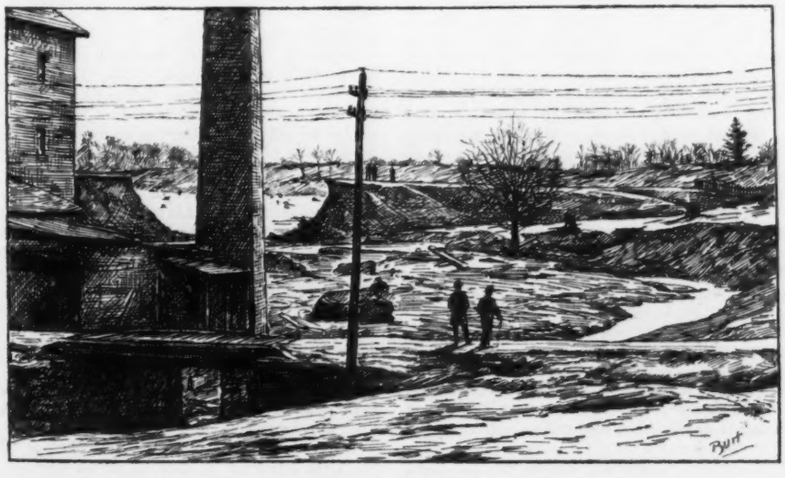
A few days previous to the date given, the escape of water through the dam had been noted, but no particular attention was paid to it as "it seemed just the same as it had been every year at this time." But at 7.15 in the morning, the weak structure gave way under the accumulation of water and ice behind it, and the flood carried off a building in its path, with the loss of life referred to.

The only remarkable features about this dam is that it stood as it did in the condition described; and the only moral to be drawn from the accident is the necessity for a more careful inspection, repair or renewal entire of the many similar structures in this country that simply await the "other straw" to bring about equally fatal results.

We are indebted to W. R. BURKE, County Engneer, Ingersoll, for photographs and local newspapers descriptive of the accident.



A Strange Collision.—(*From a Photograph.*)



The Broken Dam at Ingersoll, Ont.—(*From a Photograph.*)

A Strange Collision.

The collision, whose effect we illustrate herewith, was of a passenger train moving at about 15 miles an hour, with a freight train standing still, and was due to an unexplained failure of the air brakes to act. The passenger engine had been reversed for some time before the collision, and mounted the stationary freight engine in the extraordinary manner shown, driving back the freight cars behind several hundred feet, and smashing the platforms of wo of the passenger cars, besides the injuries shown. The accident is notable for three things:

1. For the way in which the engines interlocked, which is more than curious; it is instructive. For the same reasons that a candle can be shot through a piece of wood, the engines have assumed a very different position from what they would have been likely to assume, had they come together with equal velocity. In the latter case they would have been more likely either to rear up on end, as has sometimes happened, or to have smashed into each other as far as they could and then stop. Some extra strong pilot, or other peculiarity may have helped to the very unusual result shown, but it would have been most unlikely to happen had both engines been in motion. In this case, one engine had *all* the tendency to go ahead, and the other *all* the tendency to stand still, and one see the effect.

2. The peculiar way in which the tender walked into the baggage-car is notable, and probably due to there being an inferior coupling between them.

3. And chiefly,although the train consisted only of five cars "*the passengers in the Pullman coaches experienced only an easy lurch, and did not know a collision had taken place until told so.*" This was likewise the case at a much worse collision, at Jackson, Mich,, to a much longer train, but it illustrates what an effective and gentle brake it is to the rear cars to have a general giving way at the head of the train.

We are indebted to W. R. BURKE, C. E., for the prompt forwarding of the details and photographs of this affair.

The Astrop Dried Sewage Process.

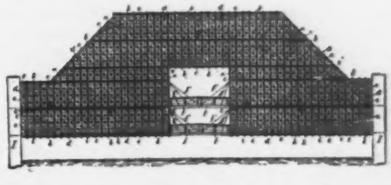
The *London Times* describes the Astrop process of converting sewage sludge into a marketable, dried manure. These works are at the Walthamstone sewage farm: the motive power is a 12 horse-power engine. On the second floor of the building is a 400 gall. tank into which the sewage is pumped after it is chemically treated, and deprived of its supernatant water by the Jerram process. The water-extracting machine is about 24 x 8 ft. in dimensions and is fed by a 6 in. pipe from the tank above.

This machine consists first of a large sludge-vat in which are two hollow perforated cylinders 12 in. in diameter, and covered with wire gauze with 6,400 meshes per square inch. These cylinders revolve against cleaning brushes. By means of a pump a partial vacuum is created in these cylinders, and the result is, that about 60 per cent. of the moisture contained in the sludge is extracted at this point. From this tank the sludge is delivered by a sluice valve on to an endless traveling web of wire gauze of the same mesh as that on the cylinders, the web being as wide as the machine—namely,8 ft. This web is supported by brass rollers placed at intervals, and passes under two rollers and over two of Korting's exhausters, which remove another 10 per cent. of the moisture. The sludge has now assumed the consistency of a thick paste, and in this condition it is passed between five pairs of rollers furnished with iron scrapers. From the last pair of rollers the semi-dried sludge falls into a hopper, whence it is fed into a disintegrating cage on the lower floor, and in which it is finally disintegrated and dried by a blast of warm air, leaving only about 5 per cent. of moisture in it. The solid particles of the sewage now assume the form or a coarse powder which falls through the wire meshes of the disintegrator on to the head of an Archimedean screw running in a long trough, and by which means the powdered manure is delivered into a pit, whence it is packed in bags for the market.

While the system is reported as being satisfactory, and the product as being of high manurial value, no figures are given as to the cost of the process, and the relation of this cost to the selling value of the product. The process would probably do well under certain conditions, and with small quantities to be dealt with.

A Queer Bridge.

The above recently patented "truss suspension-bridge" requires no comment, further than to say that according to claim 1, it is "a combination with the abutments *I* of rods or pipes *c* and horizontal and



diagonal wires *a* and *d*." We fear that about all the dividents to be collected from this valuable patent are already secured by the U. S. Patent Office.

RAILROAD official (to president of the company)—I am inclined to think that the big iron bridge has been a trifle unsafe.

President—Nonsense. Why do you think so?

Official.—Beause this dispatch says it has just gone down with a train load of passengers.—New York *Sun*.

On the Best Manner of Making Use of the Services of Experts in the Conduct of Judicial Inquiries.

BY CLEMENS HERSCHEL, C. E.

"*Periti potius judices sunt quam testes*" A common expression with law writers of the Middle Ages.
"*Et generaliter unicuique in arte sua experto credendum est.*"

DURANTIS, A. D. 1237-1295.

"Experience," said Mr. JUSTICE GRIER, "has shown that opposite opinions of persons professing to be *experts* may be obtained to any amount; and it often happens that not only many days, but even weeks, are consumed in cross examinations to test the skill or knowledge of the witnesses and the correctness of their opinions, wasting the time of the court and wearying its patience, and perplexing instead of elucidating the questions involved in the issue." (Winans *v.* N. Y. & Erie R. R., 21 How. 88, 100.)

Said Judge MCLEAN: "The opinions of the *experts* who have been examined are in conflict; and so far as my experience goes, this has been uniformly the case where *experts* have been examined." (ALLEN *v* HUNTER, 6 MCLEAN, 303.)

And inasmuch as eight doctors had been deposing in favor of the plaintiff, while eleven of the profession had been found who could do, and who had done, a like service for the defendant, Judge MCLEAN's embarrassment found but a natural expression. Lord CAMPBELL, in the case of the Tracy Peerage (10 C. & F. 154, 191), placed on record his judgment of the worthlessness of the system which would fain evoke a judicial answer or opinion from a human being whose preparation for thus thinking and speaking had been a life of weeks or months, may be, in the environment which ordinarily falls to the lot of the advocate; not to speak of the futility of expecting to get such an opinion from a man placed in the witness stand, and condemned to say naught but in answer to ingeniously concocted, perhaps more or less rasping questions. "I do not mean," said Lord CAMPBELL, "to throw any reflection on Sir FREDERICK MADDEN. I dare say he is a very respectable gentleman, and did not mean to give any evidence that was untrue; but really this confirms the opinion I have entertained, that hardly any weight is to be given to the evidence of what are called scientific witnesses; they come with a bias on their minds to support the cause in which they are embarked: and it appears to me that Sir FREDERICK MADDEN, if he had been a witness in a cause, and had been asked on a different occasion what he thought of this handwriting, would have given a totally different answer." And many more such *dicta* of the most eminent judges, all in entire consonance and accordance, could be cited in condemnation of the existing method of making use of the services of experts in the conduct of judicial inquiries.*

If, on the other hand, there be a *dictum* on record emanating from any judge of recent times, in praise of the system now spoken of, the writer has not seen it. To find such, one must go back more than one hundred years, to the very beginning of the practice of calling upon scientific men for their opinions from the witness stand.

The language of the practising attorney is not often found in musty, nor even in mere dusty tomes, else the literature of sarcasm and of cutting scorn, directed against the present system of employing experts to give testimony, or against the product of that system, the expert himself, would surely leave no opportunity for further original contributions of the same kind. There is no difficulty, however, in culling such ebullitions from treatises upon the law. "When we consider the conflicting character of testimony coming from experts, and often its one-sided and partisan character; and above all, the tendency of the most mature and well-balanced minds to run into the most incomprehensible theorizing and unfounded dogmatism, from the exclusive devotion of study to one subject, and that of a mysterious and occult character (insanity), we cannot much wonder that some of the wisest and most prudent men of the age are beginning to feel, that the testimony of experts is too often becoming, in practice, but an ingenious device, in the hands of unscrupulous men, to stifle justice, and vindicate the most high-handed crime." And again: "There must therefore, it would seem, be somewhat fatally defective in our mode of obtaining and applying this class of testimony. For it cannot be supposed that, under proper regulations, that there would be any difficulty in obtaining reliable scientific evidence, if the proper methods were resorted to." (Redfield on the Law of Wills.)

Experts themselves have occasionally written upon the system in whose toils they struggle.

Dr. W. W. GODDING (a noted specialist on insanity) says, in the "North American Review," June, 1884: "*Amicus curiae*, professedly, though called by opposing counsel, rather than by the judge; answering alternately yes and no to contradictory hypothetical questions, ingeniously based on selected facts in the testimony; and so, with a show of science falsely so called, leaving the jury more befogged than ever. If this is a fair view of the medical expert of our time, well may justice exclaim, *Non tali auxilio tempus . . . eget.* True science asks a different definition from this, and from such judgment, indignant, takes an appeal."

And CHARLES S. DANA, in the same number, says: "But although science has now woven itself into every detail of human affairs, it is a notable fact that the evidence of experts in medical sciences has continually lost ground, until to-day its inconsequential nature, and meagre value in helping the ends of justice, are universally acknowledged. One naturally looks for the cause. When a man of business is about to initiate some new project, he calls in the best advisers possible, gets from them facts and opinions, and makes his decision accordingly. But when a court of justice wishes light upon intricate and difficult points, it follows no such common-sense procedure. It calls in two antagonistic sets of advisers, concerning none of whom it has any assurance of special skill. The first set urges one view, the other set its opposite. The lawyers try to prove that both groups of advisers knew nothing at all about the matter. In fine, the court accepts any one as an expert, and trusts that cross-questioning will show that he is an ignoramus if he really is such. Now, since there is no certainty that real experts have been called upon either side, or that the lawyers will prove non-expertness if it exists, or that the witnesses will not testify for the side which calls them, justice truly has a meagre chance. It is very plain from this that in the matter of medical expert testimony it is the mode of procedure which is at fault, and not the doctors, who, however, generally get all the blame."

Finally those twelve plain men from the people, the details of whose deliberations are so seldom known outside of the jury-room, have yet occasionally told us what they think of our modern English and American method of using experts as witnesses; this evolutionary product, at its present stage of development, of our system of judicature, and of the drift of our judges, lawyers, litigating parties, and experts. Said the jury in the NICHOLSON murder case (Boston *Daily Advertiser*, Feb. 18, 1885): "The undersigned, members of the jury that tried JAMES NICHOLSON, make the following statement: On retiring, the jury decided to throw out all the medical testimony on both sides. We then decided that NICHOLSON did not have *delirium tremens*. We are all of the opinion . . . ."

In other words they said to the experts, what doubtless many a jury (and judge) has said before them, "A plague on both your houses," and then proceeded to decide, as well as they could, in the light of the other testimony before them. A very farce, one would say, looking at it in the calm light of review. Two parties are in court; under the advice of counsel, and availing themselves of all means of trial left open to them by the existing processes of trial, they seek and pay dearly for the services of men supposed to be more than ordinarily capable of arriving, and of aiding others to arrive, at the truth: all the members of the court and parties present spend months, may be, in examining and cross-examining these men of science or of expert knowledge; and in the end, the proceedings of deliberation are opened by deciding to throw out all the testimony of this superior order, offered on both sides.

The wise Chancellor OXENSTIERN's saying "Go forth, my son, and see with what little wisdom this world is governed," has been often cited, but it is doubtful if it ever had a more apt application than to the subject now under discussion. In this opinion are agreed, as has just been shown, all parties having knowledge of court proceeding which involve the use of expert testimony; judges, lawyers, law writers, experts, and the jury vie with each other in condemning the existing system.*

The only variation found in such expression of opinion is when the form of condemnation strikes, instead of the system, the experts themselves; but as may be readily shown, it is the system which is at fault; and in every case, the same men, were they placed in a different environment, would act far more acceptably, to say no more.

Some opinions have already been quoted, tending to show that, by general acknowledgement, a remedy must be sought in the direction of a different method of making use of the services of experts, and it is not difficult to cite still others. To treat of this part of the general subject is the object of the present paper. I set out to write it with some diffidence, as he who, wandering along the ill-defined border-land of two properties, is fearful lest he stray too far into foreign territory, but emboldened by the fact that all the articles in current literature, or even in books, on expert testimony, that have come to my notice, say but little on this very essential part of the subject. They generally confine themselves to an exposition of what they are pleased to call the "law of expert testimony," being a compilation of decisions and sayings upon it (a sort of bouquet of "wise saws and modern instances," as Shapespeare would have it), until the layman is left to wonder whether the "law of expert testimony," as a science, had yet got beyond the first of the three stages of the development of all sciences, that of authority; and whether the other two stages, that of experiment or observation, and that of established law or positivism, were not worth trying for; whether in short, and in truth, there be no such thing as principles or laws governing this twig of a branch of the law.†

In an article in the January and April numbers of the "American Law Review," 1871 (being a prize essay, May 1, 1870, in the Harvard Law School), the writer says: "We have have already occupied so much space on this question, that none is left in which to consider the remedies that have been suggested for rendering this class of evidence of some value in the administration of justice. No one, of course, is prepared to say that the courts can get on without such evidence. For scientific men possess knowledge without which no enlightened administration of justice at the present day can be maintained. The remedy is suggested by the nature of the abuse to be removed. *Experts* are now called and paid by the parties themselves in the suit. Nothing is more natural than that such a circumstance should tend to impress an *ex parte* character upon the evidence which they give. . . . *Experts* then, should be selected by the court, without any interference on the part of litigating parties. In that way, all inducements to give partial or biassed opinions, whether consciously or unconsciously, would be removed. The scientific witnesses have, or should have, no interest in the suit whatever. They are called merely and solely to give the court and jury instruction. They may be considered *amici curiæ*, and should be dignified accordingly. Some such scheme has received the sanction of eminent judges and jurists."

And dumping down a number of references, the author unfortunately stops short, as though his time were up, or his inclination exhausted.

In the same magazine, Oct., 1866, being Vol. I., No. 1, the late Prof. WASHBURN, of the Harvard Law School, in an article on the same subject, says this much; "What then, the question recurs, are courts to do, in order to secure to parties the benefit of using what is known in science: and at the same time, exclude the crude or partial theories, or false or biassed opinions, which are in danger of confounding or misleading jurors, from their being unable to discriminate between what is true and what

*NOTE.—See, for example, the Appendix (and in the text) of "The Law of Expert Testimony," by HENRY WADE ROGERS, 1883.

*Says an esteemed legal friend of mine: "Some way out of the present difficulty it is very important to find, for the existing system is as bad as it can be."

†This was written before I had seen "The Law of Expert and Opinion Evidence," by JOHN D. LAWSON, 1883. To the author of this philosophical book I desire to make my humble apologies for the above sentence. But this book is the exception which strongly proves the rule.

is false? The answer, it seems to me, is furnished from the present power and usage of all courts to which I have referred. When a man is offered to testify as an expert, it is the duty and province of the judge to determine, upon evidence and inquiry, whether he answers to that description or not. If he does not, the Judge rejects him and there the matter rests. Now, what is wanted in an expert is, first he should be sufficiently acquainted with the subject-matter as to which he is called to *know* what its laws are; and, in the second place, he should be honest and impartial enough to state his opinion or judgment upon these fully and fairly, so far as it can be done, and how they bear upon the issue to be tried. He should not be selected as the witness of this party or that, or to represent this view on that, or the matter in controversy. He should be like an arbitrator or a commissioner, who, standing indifferent between the parties, is to hear the facts which they have to offer; and then, by applying his own knowledge as a man of science, to form an opinion, and declare it, as a guide for the court and jury in forming a final judgment in the cause.

"I would, therefore, have experts selected by the court, as they appoint auditors to determine matters of account, or commissioners to take testimony, or to make partition of estates; or other like agents and instrumentalities in the administration of justice. . . ."

So Judge REDFIELD: "It seems very obvious, therefore, that this class of witnesses should be selected by the court, and that this should be done wholly independent of any nomination, recommendation, or interference of the parties, as much so, to all intents, as are the jurors. To this end, therefore, the compensation of scientific experts should be fixed by statute or by the court, and paid out of the public treasury, and either charged to the expense of the trial, as part of the costs of the cause, or not, as the Legislature should deem the wisest policy. The mere expense of the experts, when selected in this mode, would be as nothing in comparison with the expense which now becomes unavoidable, in consequence of the enormous consumption of time in most of the trials of this class."

In current literature, many experts have expressed the wish that experts might be called by the court, or in some way relieved from all inclination to be biassed, or suspicion, based on appearances, that they were biassed, in favor of either party. It has, to be sure, become almost fashionable in court circles, I regret to say, to sneer at experts, to impugn their motives, and to decry their honesty; as though they were made of a different clay, and were not of the same mould and form in their original sociological state as the choicest members of the juridical or of any other body. "So it is the duty of all experts, called in any case, to testify with impartiality," says an eminent Massachusetts justice; "but it is notorious that experts are called by parties in many cases who are governed in their investigations and their testimony by a partisan desire to aid the party that employs them, and not by an impartial desire to present fairly the truth of the case." But it seems to me that little good is done by condemning any class, or portion of a class, of men in this way, in a body. It would be a libelous reflection, I submit, upon an honorable profession, and could do no good, to say that it is notorious that many cases are conducted by counsel who are governed in their actions merely by a desire to win their cases, and who take any means, fair or foul, for the encompassment of that end. Most experts might reply, that however much a desire to present fairly the truth of the case were in them and moved them on entering upon a case, their surroundings and influences brought to bear upon them are in direct opposition to their being throughout actuated by any such desire; and the expert once on the stand, wicked men fairly choke off and prevent all and every desire "to present fairly the truth of the case," by the designing and rigid forms of questions propounded and answers demanded. In short, no one connected with the case, unless it be exceptionally, ever asks the expert, or places him in position to "present fairly the truth of the case;" if they did so place him,—in position to declare that truth, as to the best of his ability he saw it or could find it,—they would probably get it. The supposition that examination and cross examination will naturally develop the truth, will not apply in these cases; for the thing to be evoked is an expert opinion, not a statement of a commonplace fact or observation, or a series of such.

The most pitiful picture perhaps ever drawn, of the notoriously lamb-like lawyer running the danger of having all his fine principles and feelings ruthlessly devoured by the notoriously wolf-like expert, may be found in the article in the "American Law Review," (Oct., 1886) already referred to. "But I have reason to believe," says the author, "that while it may be too late to refuse to allow testimony to which usuage and precedent have almost given the sanction of prescription, it has often disturbed and distressed sensitive minds, when seeking to ascertain what the truth was, to be obliged to resort to the opinions of men who have seemed to regard their line of duty as lying in the direction of the success of the one who employed them, rather than of the discovery and establishment of truth." I may have occasion to refer to this sentiment again, in speaking of the fundamental object of all judicial inquiries. For the present, it need only be said, that where so many minds in all professions are actuated by an innate desire for the establishment of truth, there surely ought to be no obstacle kept in the way for the attainment of so laudable an object.

It is undoubtedly true, however, that the present practice has developed—in limited numbers, be it noted—the professional expert or lawyer in scientific disguise. This is how one of them has described the species: "The expert witness stands with bare breast, his entire moral and professional career from childhood open to the shafts of the enemy. If he be proved—and sometimes, if he be accused of being—untruthful, ignorant, incompetent, over-pretentious, careless, or any one of a dozen undesirable things, over goes not only his present case, but his entire future as an unblemished and unvanquished expert." ("American Engineer," Sept. 12, 1884.) He stands, as does the gladiator, it would seem,—an Ishmaelite, his hand against every man, and every man's hand against him. But if wise justices do not like the picture, it must be very evident that to a great extent they have only themselves to thank for it. It is the fit product of the system, commenced, perhaps, in good enough faith in FOLKES *v* CHADD, but unfit to be applied to aught but men commanding the respect of both parties and the court, and really arbitrators, though speaking from the witness stand. It was in some such guise that Mr. SMEATON was called in FOLKES *v* CHADD, as we shall presently see. Then why not call them as arbitrators or as judicial experts? I very much doubt whether the professional expert takes any pleasure in being obliged to think and feel as above quoted; and for every one such, there are in my opinion twenty, whose chief desire is to be relieved from the false position in which they now find themselves, whenever called upon to aid in the conduct of any judicial inquiry. Very likely the gentleman quoted has had the same desire, and has despaired of ever seeing it gratified.

The experience I have had leads me to think that a recital of that experience will give weight to my views upon this matter. After a practice of some fifteen years as a civil and hydraulic engineer, during which I had served as expert witness in very many cases, I was placed in an official position, where for three years I was constantly called upon, with the aid of my expert knowledge no less than that of any other faculties I might have, to act as arbitrator in important cases. With this experience, I claim to understand the feelings and capabilities of the scientific expert, according as he be placed in one position or the other, quite well; and it is now very clear to me that the best men of any science or profession will not act as experts, under existing conditions, for such witnesses at all. Who, indeed, is oftenest heard from as an expert in court? Not the man of lasting renown and of chief honor in his profession. But rather he of

". . . your modern kind of fame,
The morning paper reeking with his name,"

But even these men would act more acceptably if judicial impartiality were put home to them; and I believe that all would welcome, or in the end be satisfied, with such a change.

Wherefore it may be said, that judges, law-writers and the large majority of experts, if not every man of them, are agreed, not only that the present method of making use of experts in judicial inquiries is not what it ought to be, but that an improvement is to be sought in the direction of placing the expert in position where he may exercise, untrammelled, the judicial functions of his mind. And at the same time, it becomes a grave question of public policy, whether the formation of expert witnesses into a profession, as is now the drift and tendency, should not be discouraged in every proper way.

[TO BE CONTINUED].

PUBLICATIONS RECEIVED.

Petroleum; its Production and Use. By BOVERTON REDWOOD, F. I. C., F. C. S. Van Nostrand Science Series No. 92. Price 50 cts.

This is a very readable and instructive treatise on the history and practice of oil production and its many products. The original matter was used in lectures on this subject before the English Society of Arts; but all matter unimportant to American readers has been here eliminated.

The Palliser Specification Blanks. For Brick or Frame Buildings. Palliser, Palliser & Co., New York.

These printed specifications are in ordinary specification form with blanks for filling in special details. They are sold at 25 cts. each and save a good deal of trouble, especially for engineers who only in an incidental way have to superintend small buildings.

Meigs Elevated Railway System. The Reason for its Departures from the Ordinary Practice, and How and Why a Safe Railway is Possible. By JOE V. MEIGS, Inventor. Boston, Mass., Pamphlet; pp. 192; 63 illustrations.

A very interesting description of a very interesting engineering experiment, containing many features of striking novelty and merit which we can notice more appropriately at any time. We are unable to perceive any engineering fallacy in the main features of his designs and claims, the strains in his obliquely placed wheels being very different from what casual inspection of so unfamiliar a form would lead one to suspect. In one feature, however—in no way an essential one to his system—he is very wrong, in claiming that a rectangular groved wheel can ride upon the right-angled corner of a triangular rail without grinding effect, since it is geometrically impossible for two circles of unequal diameter to roll forward with the same linear advance per revolution without one or the other of them sliding on the surface on which it rolls. It is unfortunate that a device which we cannot but feel possesses real merit should be encumbered with this unnecessary fallacy on which cavillers may pick and so condemn the whole.

Proceedings of the Fourth Annual Meeting of the New England Roadmasters Association. Held at Manchester, N. H. Oct. 20-21, 1886. pp. 103.

The discussions were very interesting and practical, and the statistical information presented is especially valuable. Resolutions were adopted favoring split switches with automatic stands for both main track and side track, with spring switch rod in preference to a rigid one, and that all renewals should be made accordingly. Ties 7 in. x 7 in., 9 ft. long were recommended *pro tem.*, final action being laid over till next meeting, when it is to be hoped that this action will be reconsidered by recommending 8 ft. 6 in. in place of 9 ft., which makes really a better tie. The questions of footguards and bridge-guards and floors were laid over till next meeting, with measures for gathering information in the meantime.

Practical Electricity: A Laboratory and Lecture Course for First Year Students of Electrical Engineering, based on the Practical Definitions of the Electrical Units. By W. E. AYRTON, F. R. S., etc., pp. 516; 180 cuts; well indexed. Cassell & Co., London, New York, etc.

We have seen no book that seemed better calculated to give a clear idea of the elements of electrical engineering than this, of which we hope to give later a more extended notice.

Fourth Annual Report of the Kansas Board of Railroad Commissioners, for the year ending Dec. 1, 1886.

An interesting feature of this report is the summary of local freight rates, which show that the people of the State have very little to complain of. On cereals the rates for hauls of 200 miles or over seem to be far under 1 ct. per ton mile as an average. A singular feature is that the tons moved east and west are almost precisely equal, and that grains make less than 15 per cent. of the total tonnage moved.

Second Biennial Report of the Railroad Commissioner of the State of Wisconsin. For the two years ending June 30, 1886.

The report shows 4,778 miles in the State, divided between 14 companies, all but about 500 miles being in the hands of seven great systems.

Washout.—A considerable portion of the Michigan Central R. R. was washed out April 4 by the flood caused by the breaking of the King mill dam at Ingersoll, Ont., Canada.

ENGINEERING NEWS

AND

AMERICAN CONTRACT JOURNAL.

TRIBUNE BUILDING, - NEW YORK CITY.

VOL. XVII. Saturday, April 9, 1887

D. McN. STAUFFER. A. M. WELLINGTON.

EDITORS.

GEO. H. FROST, - - - BUSINESS MANAGER.

Subscription. — UNITED STATES AND CANADA, $5.00 *per Year; $2.50 for Six Months; $1.50 for Three Months; Single Copies, 12 cents.* FOREIGN COUNTRIES, $1.50 *per Year, or 3 cents per number additional.*

Drawings and Photographs *of all new engineering works or designs, large or small, of interest from their magnitude, novelty or originality, as well as newly adopted* **Standard Plans** *for engineering structures or details, rolling stock, etc., are always desired for early publication. Also,* **Brief Technical Notes** *of the cost or manner of executing work, tests of materials, machines or other new devices, and* **News of New Construction** *of all kinds.*

Employment Notices.—POSITIONS WANTED, *50 cents, for one insertion; $1.00 for three insertions; not over fifty words.* POSITIONS TO BE FILLED. **$1.00.** *Those having positions to fill are earnestly requested to avail themselves of our facilities, in the mutual interest of themselves and the unemployed.*

As a direct result of the late disaster in Boston, we note that several trains on the Boston & Maine R. R. were detained several hours at the Noble Island bridge, in Portsmouth, N. H., while some recently detected weak spot in that structure was being repaired. No trusting to Providence in that case.

GERMAN and French architects do not seem to be quite happy over their experience to date in handling their new explosives, and *melinite, helphonite* and *roburite* have already developed an unfortunate trick of exerting their powers at the wrong time and place. The trouble appears to lie in the dangerous character of the compounds themselves and in the methods of ignition adopted. Lieut. ZALINSKI, in our own service, has been much more successful in his experiments with dynamite, and his ingenious application of a small electric battery for firing the charge is a decided advance upon foreign practice.

WE have been favored by the BALDWIN Locomotive Works with the following letter in reference to the long table giving the hauling power of locomotives of all types on all grades which appeared in our issue of March 12, 1887:

"We have examined with much interest the data contained in the proof-sheets sent us. The conclusions reached are entirely in accordance with those indicated by our experience in a number of most exhaustive tests of tractive power of locomotives, made in fulfillment of guarantees embodied in certain recent contracts. It is therefore our practice at this time to calculate our guaranteed performances on substantially the same basis as that which you have digested and summarized more fully than time has permitted us to do.

"We observe that the weights of locomotives on which table 170 is based are those stated in our last catalogue, that published in 1881. These weights do not correctly represent the practice of to-day. As you are doubtless aware, the present tendency is in the direction of much larger boilers and heavier details for given cylinders. Thus, many of our standard 16 in. × 24 in. American pattern locomotives, equipped with driver-brakes and other accessories involving increased weight, exceed the weight stated in your table for 18 in. × 24. in. cylinders. We should say that the average weights of the several classes of locomotives referred to, are at this time nearly as follows:

Class.	Total weight engine and loaded tender. Pounds.	Weight engine only. Pounds.	Weight on Drivers. Pounds.
8—24—*C.*	110,000	66,000	42,000
8—30—*C.*	150,000	90,000	58,000
10—28—*D.*	130,000	82,000	60,000
10—32—*D.*	158,000	98,000	72,000
8—28—*D.*	128,000	80,000	64,000
8—34—*D.*	166 000	106,000	90,000
10—34—*E.*	172,000	112,000	98,000

"Many engines of these classes largely exceed these figures and some do not quite reach them, but these are about the average requirements which we have to meet, and the average of what our standard engines come to. It will be noticed that heavier tenders also are required. 3,000 gall. capacity and 5 tons of coal are the least generally required for 8—30—*C*, 10—32—*D*, 8—34—*D* and 10—34—*E*. We roughly estimate weights of tenders at say 20 lbs. for each gallon of tank capacity."

The "8—30—*C*, 10—32—*D*," etc., will puzzle a good many readers, nor need they be ashamed of it, for there is probably no human being outside of the Baldwin Locomotive works who can tell off-hand what it means, without aid from a dictionary. Few people even know how the strange designations came about, but that we can explain. They are in Volapük:* The originators of that great project for obtaining a universal language which every one should understand, by introducing a new one which no one understood, rightly concluded that the greatest locomotive shop in the world was the right shop to go to for their locomotive nomenclature, and a dictionary to this part of the Volapükese tongue appears in the Baldwin catalogue. In Volapük, (see dictionary on page 59 of the Baldwin catalogue) 12 means 9, 14 means 10, 16 means 11, 18 means 12, and so on, 24 meaning 15; 28, 17; 30, 18; 32, 19, and 34, 20. The only other use of this branch of Volapük that we know of is on pages 808-9 of Trautwine's *Pocket-Book*, where it is given *without an accompanying dictionary*, making it a trifle blind, and more than a trifle absurd.

These definitions, we should add, apply only to the *diameters* of cylinders. Volapük has no terms at all for expressing stroke. To express the number of driving wheels *A* means 2, *B* means *nothing*, *C* means 4, *D* means 6, *E* means 8, and perhaps *X* means 10, for nothing is stated in the dictionary. The total number of wheels is expressed as in the vulgar tongue.

With the aid of this explanation, knowing the number of wheels and drivers under American, Ten-Wheel, Mogul and Consolidation engines, as everyone does who has any interest in locomotives, and guessing that the stroke of all was 24 in., we may translate the above table as follows:—

Engine		Weight of tons, 2,000 lbs.		
Volapük.	United States.	On Drivers.	Engine.	Eng. and Tender.
8—24—*C*	15 x 24 Am.	21.0	33.0	55.0
8—30—*C*	18 x 24 Am.	29.0	45.0	75.0
10—28—*D*	17 x 24 T. W.	30.0	41.0	65.0
10—32—*D*	19 x 24 T. W.	36 0	49.0	79.0
8—28—*D*	17 x 24 M.	32.0	40.0	64.0
8—34—*D*	20 x 24 M.	45.0	53.0	83.0
10—34—*E*	20 x 24 Cons.	49.0	56.0	86.0

To extend this contrast a little farther, a 4-wheel or 6-wheel switching engine with no truck, 17 × 24 cylinders, is 4 — 28 — *C* or 6 — 28 — *D* in Volapük, the more natural designations being 17 × 24 *S* 2 or 17 × 24 *S* 3. The Forney type (*F*) and Double-Enders (*D*) are more exceptional and a 16 × 22 o o O O o. engine might have to be thus described.

Speaking more seriously: If the secrets of all hearts could be unveiled, we would wager our copy of the Volapük dictionary that more than one order has been lost to the Baldwin works while they have been building their thousands of locomotives, by the fact that possible customers found their locomotives described in an unknown tongue which they could not understand and were too lazy to translate. We have had some direct evidence that their peculiar nomenclature for locomotives is not appreciated by the outside public.

*For the benefit of those whom this note may lead to begin the study of this new language, we may quote from a recent literary paragraph that "Volapük; the new universal language, is now within the reach of English-speaking people. Professor KIECHHOF's abridged grammar has been adapted to our use by KARL DORNBUSCH, and anybody who wishes to indulge in Volapükese can now do so comfortably. This language has been formed after twenty years laborious research by M. SCHLEYER, of Constance; he has named it Volapük from "pük," language, and "vol," universe. It has no artificial genders, a single conjugation, and no irregular verbs. The roots of its words have been borrowed from all the languages of Europe, the adjective, verb and adverb are regularly formed from the substantive, and have invariably the same termination."

In regard to the merits of their reference to the long table which we published, while the point raised in the above quotation is well taken, yet it does not appreciably affect the table from a practical point of view, since the latter is based solely upon the *load on drivers*. Any engine which has 32 or 40 tons on drivers has the same hauling capacity at slow speeds, since it is limited by the adhesion. The only way in which the gross weight of the engine affects the question is, that whatever is added to the weight of the engine is deducted from the weight of the train hauled, and *vice versa*. The size of the cylinders used with a given weight on drivers does not, or should not affect the matter at all, since they are supposed to always be large enough to utilize the full adhesion at slow speeds. The modern tendency is to use somewhat heavier total weights of engine and tender for a given weight on drivers than were common ten years ago, but for *half-loaded* tenders, which is what the table was computed for, there has been no material change, for engines of the same type so that the table may be considered as still as nearly correct as it could be made for giving what was intended,—the net hauling capacity due to a certain weight on drivers. In the size of cylinders used with given weights on drivers and total weights, there has been a very striking and rapid change, the tendency being to build heavier and heavier engines for the same cylinders, which is largely, but not wholly explained by the increase in average pressure carried.

WE presume many of our readers have seen MARK TWAIN'S account of a "darling literary curiosity" in the last *Century*—the genuine responses of public school pupils to various questions asked in recitation; but four or five contributions to the exact sciences seem to demand that we should give them the benefit of our wider circulation. The following come together under the head of "Mathematics:"

A straight line is any distance between two places.

Parallel lines are lines that can never meet until they come together.

A circle is a round straight line with a hole in the middle.

Things which are equal to each other are equal to anything else.

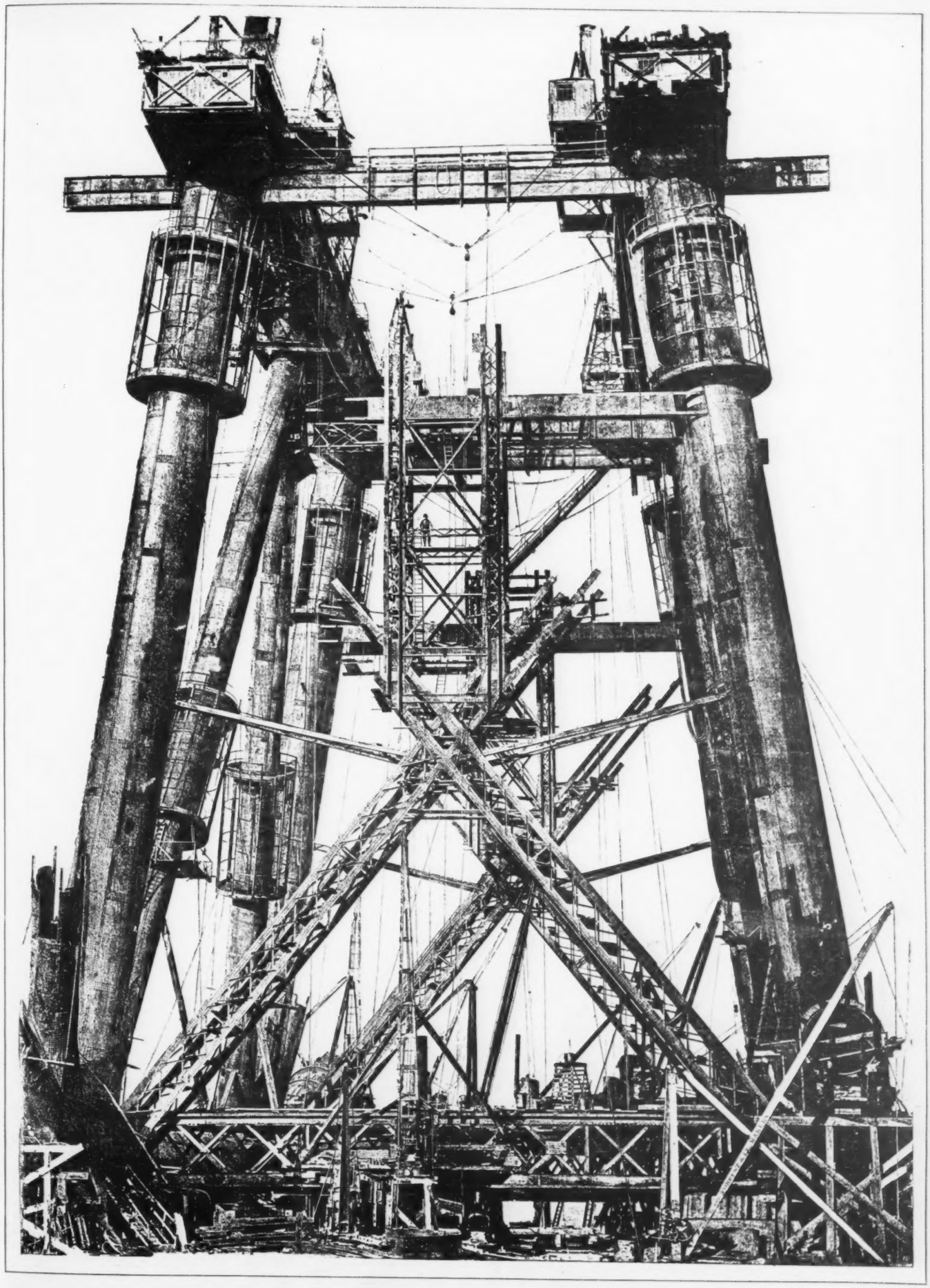
To find the number of square feet in a room you multiply the room by the number of the feet. The product is the result.

Among the contributions to physics are these:

The weight of the earth is found by comparing a mass of known lead with that of a mass of unknown lead.

To find the weight of the earth take the length of a degree on the meridian and multiply by 69½ pounds.

A body will go just as far in the first second as the body will go plus the force of gravity and that's equal to twice what the body will go.



FORTH BRIDGE.—QUEENSFERRY MAIN PIER.

ONE observes with some surprise in the "American Almanac and Treasury of Facts," edited by A. R. SPOFFORD, Librarian of Congress, that the AMERICAN SOCIETY OF CIVIL ENGINEERS AND ARCHITECTS is the only one known to him. The Am. Soc. C. E. bore that title before the re-organization of 1867-8, but as it has been taking out annual copyrights in the office of the Librarian of Congress ever since, its fame in its re-organized form would seem to have been slow in spreading.

IN answer to inquiries which we receive almost daily, we may say that the plates for the forthcoming enlarged edition of "The Economical Theory of the Location of Railways" are now nearly complete, but it is still impossible to announce positively the date of publication, further than that there is every reason to expect that it will be out some time in May. In a volume which, all told, numbers nearly 900 pages, with 206 tables and over 300 engravings and plates, there is an immense amount of detail which forbids rapid progress through the press. The index alone, which will be a very full one, is a serious undertaking.

Our Country Roads.

The improvement of our country roads, aside from the good work already being done in the neighborhood of our great cities, would seem to require much more attention than our engineers and law-makers are now giving it.

In many cases their condition is even worse than when the stage-coaches and teams of Conestoga wagons of our grandsires' day, made some care of them a public necessity. The prevailing system of requiring gratuitous labor for several days in the year from our farmers is not calculated to achieve any good result. Such labor is almost always misdirected; expended without previous plan or concerted action, and rarely under any competent direction. "Working out a road tax" generally means filling a mud-hole with stones, or leveling up with earth that is soon in itself mud, and doing the same thing over again in the following year with little if any improvement over normally bad condition.

This labor is money and it would be much better if it were paid in money. Unpopular as this might be at first, the tax-payers would ultimately find ample interest in increased comfort and convenience in the transport of himself and his products. But before this cash is expended, either the law or common sense should provide a distributor who has more knowledge and experience in such matters than has the present county or district commissioner. Simple selection for a temporary office of this kind neither makes a man a builder of roads or bridges nor provides him with knowledge requisite to pass judgment upon the plans of others.

What is wanted is an engineer, selected under conditions that will insure his competency, fairly paid for his work and clothed with power to enforce his plans, when any plans are to be carried out, and who will be personally responsible for the character of his own work and the soundness of his judgment in deciding upon the merits of county structures designed by other parties.

Any such official powers in the hands of a competent engineer, and his proposed freedom from embarrassing relations with—for such work—incompetent county officials would be such a wide departure from present practice, that we can not pretend to formulate a law upon this subject. That it would be desirable in the interest of good engineering, and true economy, even the most prejudiced can not deny: but the initiative step must be taken by those who ultimately pay in taxes or in life for the blunders of the ignorant. Even the farmer consults his doctor when sick in body, and his lawyer when his legal rights are being assailed, and never dreams of substituting one for the other or consulting himself. Yet he seems to think that he or his neighbor can build all the bridges, roads, etc., select the best plan from many for any proposed structure, and in fact do all the engineering work his neighborhood requires. That he does do it now is often the fact; but that he does it well is open to the gravest doubt.

Every county at least needs its fully recognized county engineer with whom the layman should be compelled to consult, and who should have *power* to act. When this is accomplished we can then, and only then, be considered as beginning to remove conditions that are now a national reproach. We admit that our country is new; that the government does not care for our highways as in Europe; that our counties are very often too poor to expend the sums required for good work, and that the proposed improvement upon present conditions is too vast an undertaking for any one generation, and that this improvement must necessarily be slow.

But while admitting this, we also contend that under present control the majority of our county governments, especially the poor ones, waste much money by misdirected and ignorant attempts at well-doing; that the manual labor now expended is about as effective in securing the end sought after, as would be transporting water in a sieve; and finally the sooner we commence to improve upon bad practice, and realize that our advance in other directions demands immediate attention in this direction, the better for all parties concerned.

But little more than a century ago the roads of England, now almost unexceptionally good, were about as bad as the worst of our own; and in 1770 as important a highway as that from Liverpool to Manchester, was noted as perilous from its bad condition. But thanks to Telford and Macadam, whose good advice was backed by wise legislation, English roads nearly everywhere are not only intelligently and properly constructed but also well maintained. The usual practice there is for the Local Board to appoint a district surveyor, who must first pass a rigorous examination to test his knowledge of this special class of work. This surveyor has a certain fixed area in charge and his own gangs of trained men paid by the county; he must at short intervals thoroughly inspect every road in his district and note and make all necessary repairs, and is held to a strict account for the good condition of all that pertains to his department. He is appointed practically "during good behavior," and usually holds office for a long term of years. The result of this system is that the roads are laid out according to well digested plans and superintended during construction by a man trained to his work, and the labor expended upon them is likewise experienced, and hence gives the most economical and best return for the money paid. Then too, when built, the road is maintained in good order by a responsible party whose tenure of office depends upon the care with which this is done.

In our own lack of practice we substitute a temporary board of county commissioners, or an unskilled roadmaster for this trained official surveyor; instead of the skilled workmen we have gratuituous and untrained and undirected farm labor, or a hired gang recruited from no better material working under an ignorant foreman; we annually spend in labor and cash vast sums of money that are now practically wasted; whereas were this same capital wisely invested under intelligent and experienced direction, we would soon have good roads instead of being shamed and incommoded by bad roads often growing worse.

Surely there are in every community men of influence who have the public interest sufficiently at heart to take practical steps towards bettering the present system. These men should first carefully study the ways and means and resources of their own district and commence the improvement at home. Good example is one of the best of teachers, and a good road is one of the things that any one can appreciate and all would like to have if they saw the way clear to obtaining it. While we can hardly be said to yet have a class of trained road surveyors among us, thanks to the limited demand for the article in the past, we yet possess in abundance good material to make such officials, and when called for they will not be found wanting.

The Teaching of Failures.

We could easily, if we had the facilities, publish the most interesting, the most instructive and the most valued engineering journal in the world, by devoting it only to one particular class of facts, the records of failures; of instances where engineering designs proved inadequate to the work thrown upon them; with such a full presentation of facts as to enable it to be seen just how and why they failed. For the whole science of engineering, properly so called, has been built up from such records; and not only so, but there is no engineer who, if he will look back upon the past and be honest with himself, will not find that his most valuable and effective instruction has come from his own failures. For example, an engineer with whom we are intimately acquainted, while still a young man, was called upon to lay out a small draw-bridge, He had a map, and he had a section of the crossing, and from the two together it seemed a simple matter to put the pivot pier to the best advantage in the channel. He forgot only one simple fact, that floating craft have length as well as breadth and depth, and hence that they must either go through straight or have plenty of room to turn in. As a consequence, when the draw-bridge came to be completed, it was found that, while a ship would have gone through beautifully if it could have been bent for the moment into the arc of a circle, or if it had drawn no water, yet that under existing circumstances, if ships were to go through that draw at all it was necessary to enlarge the channel materially both above and below the draw. AT the draw it was all right. He learned a lesson as to the necessity of looking into *all* the facts in designing structures, which to the best of our information and belief he has never forgotten. No amount of abstract instruction could have taught him it so effectually. Probably he needed and got yet others in later life, but none so marked and none exactly in the same line. The burnt child dreads the fire, and until he has been burned he can hardly be made to dread it.

Next to the knowledge to be gained from ones own mistakes is the knowledge to be gained from the mistakes of otehrs. The lesson is not so sharp, but then there are a great many more of them, and their value for instinction is clearly shown in the almost instructive interest which all men feel in them. For every one with the instincts of an engineer about him has constantly before his eyes the fear of making some mistake, and an object lesson as to the consequences of some mistake of others may save a hundred men

from a similar blunder, and all men feel it so, to the extent of being anxious to know if there is anything for them to learn from some new blunder.

Moreover, in a certain important sense, the structures which fail are the only ones which are really instructive. That a bridge or a dam stands up tells nothing in itself. It may be because it was well designed, or it may be merely because there has been three or four times as much material used in it as there was need for. The world is full of dams of this character from which science has gained nothing. To say that the world is "full" of them is perhaps too strong a statement, for it is rather full of too weak structures, but there are a large number of important dams in all parts of the world which stand up all right, simply because there is twice as much stone in them as there need be. It is the dams which fail which have made it possible to make their design something of an exact science, and especially those which fail after a long term of years from known and traceable causes. Even such wretched little dams as that which broke in Canada a few days since, and which we illustrate in this issue, teach more than the needlessly massive structures which exist in various parts of the world, for the fact that it stood 29 years, shows what can be done with the rudest material with a little care, and the fact that it at last gave way from gradual leakages shows the consequences of neglect. It is quite within the limits of possibility that its fall may save several others from a similar fate, by leading to timely care.

In the minor details of engineering, and of engineering structures, this is still more strictly true. The abandonment of cast-iron and some of the best features of the modern system of proportioning compressive members was largely due to the fall of the Ashtabula bridge. The fall of the Bussey bridge will probably have a similar effect in ensuring amply strong floors and floor-beam hangers. The proper proportioning of such details as water-pipe, rails, cross-ties, sewers, and many similar matters has been almost wholly built up by the records of failures, and of foundations, earthworks and retaining walls, this is still more emphatically true. In all such cases theoretical investigations have helped greatly to interpret and to generalize the teaching of experience, but the *basis* of present practice is, that experience has shown certain things to be safe, and others to be unsafe. What engineer of experience cannot trace back what he knows about clay to seeing some apparently firm, and perhaps nearly vertical slope turn into molasses of a sudden, and unanimously move down hill? No engineer who has not seen this is an entirely safe man to deal with clay.

Unfortunately, this most instructive of all classes of facts is the most difficult to obtain promptly and fully. The first and most natural impulse of those who are in any way responsible for failures whether from acts of commission or omission, is to keep the matter as quiet as possible, and in failures which cause no great catastrophe or loss of life it is usually very easy to do this; which does the less harm, because the human mind is so constituted that great and lasting impressions from other people's failures can only be produced when there is some startling result of the failure. Thus, if the train which broke down the "Tin Bridge" had only consisted of a single engine no harm at all would have resulted. The engineer would have felt the break and examined or reported it, the bridge would have been quickly rebuilt (at least half of it, let us hope) and no one would have been any the wiser. If any one had heard of the break at all it would have been simply that "one of the hangers was found defective," which would have accepted as one of the natural ills that material is heir to, and have forgotten all about it.

The lesson of this most shameful of great bridge disasters would then have been unlearned. It seems a hard and cruel thing to say, but it may be questioned if those lives so suddenly taken could have been more usefully bestowed. For such things must needs be. Men will learn the lesson of caution or care from nothing else, and one life lost now may mean ten saved hereafter. But to have this so, the lesson of what has happened must be brought out clearly, and brought out in full, and hence it follows that it is almost as much a duty to help to make clear the lesson of such disasters, to the extent of one's ability, as to avoid causing them one's self. "It is for us, the living, to see that these dead shall not have died in vain," and he who fails to do so by making clear the truth and *the whole truth* as soon as possible, from mistaken sympathy with those whose reputations may suffer thereby, or from considerations of etiquette, is showing a mercy much like that of the surgeon who should cut out but half of a cancerous growth from consideration for the sufferer. For it is quite certain that the chances of future catastrophes are increased or diminished in almost exact ratio to the fullness with which the lesson of such disasters is brought out.

We hope, therefore, that all our readers will overcome their natural reluctance to having the facts as to failures for which they are responsible made public, and will at least allow them to be made public anonymously; and when any disasters or failures of magnitude occur in the vicinity of any of our readers, or any small ones which are instructive from their character, we wish them all to understand that WE WANT THE FACTS; want them at once, and want them in full. To obtain them, and to have them useful, promptness is all-important, and we will therefore cheerfully reimburse anyone for reasonable expenses incurred in an effort to get them, without special order from us, even if—as will very likely be the case—we have duplicated the material by application to others. In all such cases photographs and drawings, *especially large-scale photographs of details*, are the most important to have and to have promptly. Those who send us such material may be assured that in the future, as in the past, it will be used for the interests of the profession and the public.

PERSONAL.

GEN. HILL has been appointed Railroad Commissioner for Virginia.

A. L. GREEN has been appointed a member of the Board of Railroad Commissioners of Kansas.

WM. A. KELLOND, of Louisville, Ky., has been appointed Assistant General Manager of the Louisville & Nashville R. R.

F. M. FONDA is announced as Superintendent of the Main Stem division of the Georgia Central R. R., with headquarters at Savannah, Ga. W. W. STARR is Superintendent of the South Carolina division, with headquarters at Augusta.

W. B. DODDRIDGE has been appointed Superintendent of the Central branch of the Union Pacific R. R. He has been Superintendent of the Idaho division.

MAJOR E. T. D. MYERS has been appointed General Superintendent of the Atlantic Coast Line from Quantico to Weldon, N. C. Major R. M. SULLY will remain Superintendent of the division from Richmond to Weldon.

W. W. PEABODY has been appointed General Manager of the Baltimore & Ohio lines west of the Ohio river.

STACEY B. OPDYKE, formerly Superintendent of the New Haven & Northampton R. R., has been appointed Assistant Engineer of the New York, New Haven & Hartford R.R., with office at New Haven, Conn.

MESSRS. CHARLES KELLOGG and THOMAS C. CLARKE have withdrawn from the Union Bridge Co., the partnership having expired by limitation, as noted in our advertising columns.

J. M. GRAHAM, Division Superintendent of the Northern Pacific R. R., at Jamestown, Dak., was elected Mayor of that place on April 2.

GEORGE E. ELLIS, of Springfield, Mass., has gone to Durham, N. C., to take charge of the construction of the water-works.

WM. M. CLEMENTS, Superintendent of the N. Y., P. & O. R. R., has been appointed General Manager of the Baltimore & Ohio R. R., with which road he was formerly connected.

SENATOR G. S. ROBINSON, of Storm Lake, Ia., has been appointed Railroad Commissioner, to succeed Judge MCDILL, whose term has expired.

GEO. A. KIMBALL, City Engineer, of Somerville, Mass., has resigned; he will take up a private practice, and make a specialty of water supply and sewerage.

W. G. RAOUL, ex-President of the Georgia Central R. R., has been appointed President of the Mexican National Ry.

THE following officers of the Anniston & Cincinnati R. R. Co., have been elected: President, A. L. TYLER; Vice President, SAMUEL NOBLE; Treasurer, D. T. PARKER; Secretary, H. L. WRIGHT; Chief Engineer, C. C. WRENSHAW. Work has been commenced on the road.

C. B. SHANLEY, N. SCHMITZ, JAMES F. WILSON, P. NOLAN and T. MURRAY have been appointed Assistant Engineers by City Engineer RUNDLETT, of St. Paul, Minn.

J. F. HINCKLEY, Chief Engineer of the St. Louis, Arkansas & Texas Ry., Texarkana, Tex., will have charge of the construction work, and all employés of the Construction Department will report to and receive instructions from him. Contractors for grading bridging, cross-ties, etc., to be used in construction, will be under the immediate supervision of the Chief Engineer, and his instructions will be obeyed and respected. W. P. HOMAN is General Manager.

CORRESPONDENCE.

Muscatine Water Works Co,
MUSCATINE, IA., March 24, 1887.

EDITOR ENGINEERING NEWS:

What is the rule used by our American engineers in figuring the strength of steam boilers, supposing the plate to stand a tensile strength of 60,000 lbs., what is the safe pressure you can carry on the boiler, and why are these rules used? By answering you will confer a favor and settle a dispute.

Yours truly, W. W.

[Conceive the boiler filled with semi-circular blocks of wood, fitting close to the outside shell, and leaving only a thin film of steam between them. It will then be clear that *inside diameter* × *pressure per sq. in.* gives the tensile strain on the boiler shell and this, divided by twice the thickness of boiler shell gives the tensile strain per sq.in.on the metal. The ultimate strength of the solid plates varies from 50,000 to 70,000 lbs., and the strength of the riveted joints from 50 to 80 per cent. of this, according to whether they are single or double riveted and punched or drilled. A working maximum pressure of about one-fourth of the ultimate strength, as thus determined, is often used, but one-sixth is considered better practice. To cover all the conditions requires a very large table.—ED. ENG. NEWS.

Henderson Pivot Turntable.

NEW YORK, April 4, 1887.

EDITOR ENGINEERING NEWS:

The article in ENGINEERING NEWS of April 2, page 214, describing the "Henderson Pivot Turntable" (Lowthorp patent) may create impressions that the "general table of dimensions" is for the wrought-iron tables, whereas these dimensions are for cast-iron tables. As it is not necessary to have patterns for the wrought-iron tables they can be made any length, and they also bear heavier loads. It also states that these tables have been used on thirty roads or more in their "*old cast-iron form*" when in fact most of

the roads referred to have the wrought-iron tables in use; however, a large number of cast-iron tables are in use, chiefly on Southern lines and are giving perfect satisfaction. Both style tables have the Lowthorp patent center bearing.

Yours truly,
F. JORDAN.

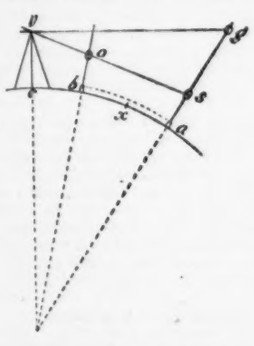
Allowance for the Curvature of the Earth.

3301 *Haverford St.*
PHILADELPHIA, March 27, 1887.

EDITOR ENGINEERING NEWS:

In the NEWS of 18th December last, Mr. H. C. PEARSONS criticizes Prof. I. O. BAKER's remarks on "the adjustment of the wye level, as also the article of Mr. TRAUTWINE on the same subject (see pages 192-193 of his "Engineer's Pocket-Book").

The "Pocket-Book" article in question, I may here remark, treats of the adjustment of the *long bubble tube of the transit*, and not of that of the wye level. For the latter it directs to lift the telescope out of the wyes and reverse it; a method which is not open to the objections urged by Mr. PEARSONS. This, however, does not relieve the article from the force of Mr. PEARSONS' objection, which is that the article assumes the line *vs* (see sketch herewith) to be horizontal to the point *c* where the instrument stands, and that it



thus makes no allowance for the curvature of the earth. There can be no question as to the correctness of Mr. PEARSONS' position. The method theoretically needs the correction for earth's curvature. The only question is as to the *importance* of the error caused by its neglect; and my delay in writing you upon the subject has been due to want of a convenient opportunity for approximately determining that importance.

Upon the top of a two-story 8-inch brick wall, I have had built (for another purpose) a concrete tower about 2 ft. high, in the top of which is imbedded the lower plate of the tripod head of one of HELLER & BRIGHTLY's best wye-levels, the telescope of which magnifies thirty times; and upon the wall of another building about 600 ft. distant and on a level with the instrument I had pasted a piece of white paper, upon which were drawn two black lines, each one-eighth of an inch wide, with a white space one-eighth of an inch wide between them. I thus had both instrument and target firmly fixed.

When the distance from instrument to target is 650 ft., the correction *g s*, for curvature is (after deducting the correction for refraction by the air) about one-tenth of an inch, so that my marks, an *eighth* of an inch wide and 600 ft. away, covered a wider space than the correction requires. Yet I found that one of the eighth-inch lines was just about covered by the apparent thickness of the horizontal cross-hair. It was impracticable, even under these favorable circumstances, to determine whether the hair cut the top or the bottom of one of the eighth-inch lines; and I doubt whether it would be possible, with the average instrument mounted upon a tripod, to adjust the telescope with any certainty to a change of even *three*-tenths of an inch in the height of the target 650 ft. away; so that until the distance from instrument to target considerably exceeds 650 ft. (as it is hardly likely to do) the consequences of neglecting the correction must be practically nil; and I have, therefore, contented myself with noting the theoretical error in a foot note, as is done by Prof. J. B. JOHNSON in his recent "Theory and Practice of Surveying."

I agree with Mr. PEARSONS, that "instead of the tentative method of finding the equal readings (*b o* and *a s*) of the rod on the two pegs (*a* and *b*) as given by Mr. TRAUTWINE (see his Engineer's Pocket-Book, pp. 129-193), it will be better to find it by direct calculation, as explained by Mr. BAKER (see ENGINEERING NEWS, Dec. 4, 1886, p. 357)," and I have revised the article accordingly.

JOHN C. TRAUTWINE, JR.

The Burlington Close Coupler Tests.

CHICAGO, April 1, 1887.

EDITOR ENGINEERING NEWS:

The following gives the results of the tests made under the direction of Mr. G. W. RHODES, Supt. of Motive Power, Chicago, Burlington, Quincy Railroad, to determine the effect on the motion of trains of loose link and close couplers.

We left Burlington on Monday morning on one of their regular freight trains, with two wa rs with slidometers in each car. The first five cars in the train were equipped with the air brake, which was used in connection with the hand brakes set on the rear cars in making all stops. There were thirty-two cars in all the train as far as Creston, from there to Pacific Junction, twenty-three cars were all that could be hauled, owing to the continuous heavy grades on this division. The train-men were instructed to handle the train precisely as they did every day. This trip was made with the link slack to 3 in. between each car. One of the way cars being placed near the forward end of the train, and the other at the rear end of the train. Although the train was handled with care in making stops, and in passing over sags in the roadbed, the shocks at times were very severe. A second trip was made from Creston to Pacific Junction and return, with a similar train; iron wedges being placed between the draw-bars taking out the link slack, thus leaving only the spring slack, the same as if a close coupler had been used. The train-men were instructed to handle the train as they had done the previous one (being the same crew) excepting that the braking was to be done entirely with the air brakes on the forward end of the train. In making the stops and passing over sags, the shocks were hardly perceptible. At one point on the road the engineer was instructed to make an emergency stop which he did (running at a speed of about 8 miles per hour up grade) by applying the brakes, and reversing his engines. In this case the shock was no greater than a number of shocks caused by making a careful stop, when the link slack was used. At another point the train was stopped on a grade of about 53 ft. per mile with a view of testing the question whether or not an engine could start a train, if stopped by any cause, as easily with a close coupler as with link slack, and it was proven beyond a doubt that it could be done fully as well, and without the danger of breaking apart, as there was no jerk in any part the train. We spent three days making these tests, there being present a number of officers of the road. And it was fully proven to the satisfaction of all present that the link slack in a train was of no advantage whatever, but a disadvantage as compared to a close coupler in handling a train under any conditions. B.

[This corresponds with the results announced last week, and with previous tests at Burlington. We think there can be no doubt that it correctly indicates the facts.—ED. ENG. NEWS.]

Rainfall in Choctaw Nation.

St. Louis & San Francisco Railway Co.
FORT SMITH, Ark., April 4, 1887.

EDITOR ENGINEERING NEWS:

Noticing your weather table in number for March 19, I note below rainfall on summit of main divide 60 miles south of Fort Smith in Choctaw Nation for five months:

Nov. 16.		1.69 in.	
Dec. 23.		0.15 "	
Jan. 12.			5 in. snow.
" 22.		0.85 "	
Feb. 2.	0.5		
" 6.			
" 7.	2.17		
" 8.			
" 13.	3.60		
" 17.	0.55		
" 25.	0.01	6.83	
Mar. 4.	0.6		
" 5.	2.95		
" 9.	2.10	5.65	2.10 in three hours.

Yours, W.

M. M. BETHLEHEM, Pa. New York City Civil Service Examinations are at Room 11, City Hall, New York. Mr. PHILIPS, Secretary.

TECHNICAL NOTES.

Mr. JNO. JAS. WEBSTER, in a recent paper on Dredging read before Inst. of C. E. London, stated that the depth of highwater in Glasgow harbor has been increased from 5 ft. 8 in., to 26 ft. and 60,000,000 cu. yds. of material had been dredged out in 40 years, and 1,500,000 cu. yds. were now dredged annually to maintain the channel. The author from experiment has framed the following emperical formula to ascertain the horse-power requisite to dredge different material under different circumstances:—If H was the height of the top tumbler from the surface of the ground and W the number of tons to be dredged per hour, then.

$1\ HP = 0.040\ W\sqrt{H}$ for very stiff clay or mud.
$= 0.034\ W\sqrt{H}$ for hard clays and indurated mud
$= 0.026\ W\sqrt{H}$ for soft mud and light sand.

STENO-TELEGRAPHY, invented by M. CASSAGNES, of Paris, is a system of transmission by which a despatch may be sent in short-hand and printed at the distant station in stenographic characters at 200 words per minute, if sent by hand, and more with the use of the automatic process. *Engineering*, of March 28, illustrates and describes the system at length.

THE Boston limited express over the Boston & Albany has been lighted by electricity and by steam from the engine since Wednesday of last week, so that it enjoys the distinction of being the first train ever run in this country without a possible source of fire in any car. The Martin steam-heating apparatus, which is reported to have been adopted on the New York Central, has stood the trial sucessfully for the 240-mile run, and the cars are admirably heated. Each coach is fitted with 24 incandescent lamps of 16-candle power. The light is brilliant enough to make reading easy in any part of the car. The Julien storage system is the one in use, the storage batteries, charged at the terminal stations, being carried in a compartment under the middle of the cars. Two lights illuminate the platforms. Altogether it is a very fine train and doubtless only a premonition of what is to become general.

THE growth of the Peabody fund in London is something marvellous. The fund in 1873 amounted to but little over £650,000. It is now £910,668, equal to an average increase of 2.62 per cent. for 13 years. It was increased last year by £29,656 or over 3 per cent. in spite of very low rents and full maintenance of the buildings, which now include 18 groups of buildings, with 5,014 separate apartments, averaging 2⅕ rooms each. At this rate if it can be maintained, the fund will amount to nearly $100,000,000 a century from now. No wiser nor more beneficent charity was probably ever founded.

THE most extensive application of the most approved form of interlocking block signalling which has yet been made in this country was begun last week, the Erie Railway having closed a contract with the Union Switch & Signal Company for a system of block signals and interlocking switches, with the Sykes attachment, between Jersey City and Turners, 49 miles which is to be completed by the middle of June, at a cost of $60,000 or about $1220 per mile. This portion of the road has an immense suburban travel.

The system requires the two operators to be in full accord before a clear signal can be given, and further requires that the section between them shall really be clear of obstructions before the signal can be given. The necessary equipment will consist of 27 towers, or one every 1.8 miles on an average, while there will be complete systems of interlocking switches at ten points: East and west ends of the Bergen Tunnel, Seamens, Hackensack drawbridge, New Jersey & New York Junction, Rutherford Junction, Ridgewood Junction, Sterling Junction and Southfield.

Work will begin immediately, and 200 men will be employed on the work.

According to a report prepared by a Mr. BOYD, C. E., and recently presented in London, which is claimed to be based on thorough investigation, it is

admitted in Panama that the company will require at least $440,000,000 in addition to the money already spent. As he declares that the work cannot be completed in less than twelve years, and as the annual interest and administration charges are even now $16,000,000, this addition would raise the cost of the canal to something like $820,000,000, while the company's obligations would amount to more than $1,200,000,000 for the last loan caused a debt of $90,000,000 and yielded only $40,000,000 in cash. The entire cost of the Suez Canal was less than $100,000,000. Whether these precise figures are correct or not they correspond with all the probabilities, and the substance of all other authoritative information.

THE days of free passes from State to State have terminated this week: let us hope forever. The practice of issuing them had a modest and inoffensive beginning fifty years ago, but had grown to be a great and crying abuse. Amusing accounts of the sudden influx of dead-heads on the last few days before the act went into effect have been published; as also the very probable statement that passes have been issued with great freedom to almost any one who applied for the past few weeks, for much the same reason that the meanest criminal is allowed to order his own breakfast on the day he is to be hanged. If the money saved by this effect of the Inter-State commerce act during the first five years could only be expended on heavier rails, better ballast, stronger bridges, safe bridge-guards, and similar matters, throughout the United States, it would benefit the roads and the public in a double way which would be quite as important as the first,—but that is too much to hope.

G. W. BREMMER, of London, has a new process of sewage purification. He uses a natural phosphate of alumina of volcanic origin and obtained from Redonda, a small desert island in the West Indies, and with this two potassia minerals found among the debris of Mount Vesuvius. These are submitted to a cheap chemical process and are claimed as one of the most powerful disinfectants and purifiers extant. Their combination has been known before, although the discovery of the minerals is new. They also possess fertilizing properties adding to the manurial value of the sludge. It is reported that 65,000 gals. of raw, foul sewage were completely purified in one hour at a cost of 4*s*. 6*d*. The effluent water is free from impurities.

THE Judkins Railway Train Signal Co., of Boston, has introduced a system of electric signals, as a substitute for the bell-cord in which the current is supplied by a small dynamo and engine in the locomotive, the two combined only occupying a space of 8 × 6 × 10 ins., only 10 lbs. pressure being required. By using a dynamo instead of batteries, the advantages of a closed circle are obtained, and an even, strong and always reliable current is assured. Any number of cars can be supplied with the signal. Trains on the Old Colony are being equipped with the signal.

What the special advantage is over the Westinghouse system, which uses the air-brake pressure for the same purpose, is not clear, unless perhaps in economy of first cost.

PHILADELPHIA contains 129,383 square miles; the average annual rainfall is 45.19 in.; the aggregate weight of the water falling in one year upon this area is 424,478,970 net tons; or in volume we would have 13,580,327,043 cu. ft. This is equivalent to about 95 per cent. of the total annual coal output of the world.

THE latest thing in the way of a device for heating and lighting is a contrivance for using stored-up gas for both purposes, light being furnished by ordinary burners and warmth by small heaters placed under the seats on a hot water coil, something on the plan of a Baker heater. An automatic apparatus shuts off the gas in case of a smash-up, and this prevents danger of fire. Experiments with electric lighting machines are still being made by the New York Central & Hudson River R. R.

IT is reported that safety guards are to be put on all the high bridges along the Buffalo, Rochester & Pittsburg Railroad. We presume this means the Latimer re-railing safety guard.

THE powerful hydraulic lifting jacks to be used on the Canal du Centre, at Mons in Belgium, are made with a cast-iron cylinder as a water-tight lining; but to resist the enormous strains required, this cylinder is reinforced by rolled soft steel coils 6 in. deep, bolted together and shrunk over the cast-iron body. A circular supply-tube surrounds the press, and by smaller diverging tubes uniformly conveys the water-pressure without weakening the press.

TESTS on the Chicago, Milwaukee & St. Paul Railway showed 75 lbs. of steam per hour condensed for heating cars at usual speed at a temperature of 20° to 40° Fah., with 270 ft. of piping, but the car could only be kept cool by keeping all ventilators open, and shutting off steam occasionally. Mr GEO. GIBBS, Engineer of Tests, estimates 17½ lbs. coal per car per hour at 10° Fah., and found that when hauling a train of 11 coaches at 40 miles per hour 8½ per cent. of the locomotive capacity seemed to be required, on the supposition that there was no reserve capacity in the locomotive.

The latest trial of Lieut. ZALINSKI's pneumatic dynamite gun gave the following results:—

Four shots were fired, each shell containing 50 lbs. of dynamite. The air pressure was 1,000 lbs. The first shot took 9 3-5 seconds to travel 1,816 yds., and on touching the water it exploded. The second shot, with a slow fuse, struck the water 2,500 ft. away, ricochetted and disappeared. A second later a huge column of mud and water arose for many feet. The third shot, with the gun at an elevation of 33½°, was a failure, owing to a delayed fuse. The fourth shot, at the same angle of elevation, was twenty-five seconds in the air, and it struck 3,868 yds. away, or about two miles and a quarter.

ACCORDING to a paper lately read by Mr. GEO KIERNAN before the Manchester Association of Engineers, there are now in use in England vacuum brakes on 4,092 engines and 24,035 carriages, and compressed air brakes on 1760 engines and 14,869 carriages.

MR. CLARKSON, a north country gentlemen, some 85 years old, who surveyed the railway between Leeds and Derby under GEORGE STEPHENSON, recently related an incident connected with that period. Mr. CLARKSON said he remembered STEPHENSON calling all the engineers together at the end of their survey at the Tontine Hotel, Sheffield. At the conclusion of the business Mr. STEPHENSON mounted the coach in a merry mood for London. "Now," said GEORGE, addressing the mail coach driver and guard, "What's to be done with you saucy fellows when these grand railways are completed?" "Well, Mr. STEPHENSON," said the ready-witted driver, "I don't know; you'll just have to make civil engineers of us."—*The Railway News.*

SOCIETY PROCEEDINGS.

American Society of Civil Engineers.—The meeting on last Wednesday evening was largely attended, President WM. E. WORTHEN in the chair. After the reading of the minutes of the last meetings, the Secretary read a circular from the Committee on the 24 O'Clock system to railway companies calling their attention to the progress made and the experience on roads which have already adopted the system, and presenting a series of questions to be answered in time for presentation by the Committee on April 23. Mr. E. BATES DORSEY, Member of the Society, was then presented by the President with the Norman medal, awarded to him in recognition of his paper on "English and American Railways Compared."

The discussion of Mr. WM. METCALF's paper on "Steel; some of its Properties; its use in Structures and Heavy Guns," being the order of the evening, this was commenced by Lieut. JAQUES, of the United States Navy. After speaking in complimentary terms of the subject matter of the original paper, Lieut. JAQUES outlined a plan for a competitive test of cast-steel rifled guns, of 6-in. calibre and high power and made of Bessemer, open-hearth and crucible steel; the competition to be open to the world and at the expense of the gun makers as far as the cost of the gun was concerned, and ultimate efficiency to be the ruling condition. In commenting upon Mr. METCALF's statement that heat and static pressure in the manipulation of the requisite steel, was superior to forging in good effect, the speaker asked the question why this method was not employed by steel-makers instead of the machines that are in universal use. In answer to this query Mr. METCALF replied that as there were some 6,000 different shapes required in his own work alone, the hammers and rolls were as yet the only means of economically producing these; while the same good qualities, and better, could be obtained by casting in any mass, this casting could not be applied to merchant shapes.

Dr. R. J. GATLING followed and thought that gun-steel should not be too hard or too soft and not hammered; for the result of this latter treatment was to render the perfect homogeneous character of the mass less reliable. The best steel for guns was perfectly homogeneous mild and tough and of high elasticity. He believed it was perfectly feasible to make steel guns on the Rodman principle. Mr. F. C. COLLINGWOOD in a few remarks referred more particularly to the use of steel for structural purposes in Europe and America. Our makers have so far met the demands made upon them for structural steel and he believed that the system proposed by the author of the original paper was worthy of a full test of its stated merits.

Mr. A. H. EMERY spoke on the question at some length, and while he had given the subject of guns and projectiles very considerable attention, his greater experience was in the behavior of the materials which would enter into them. He acknowledged the good work of the Rodman cast-iron gun but pointed out that the conditions had changed very much in the last 20 years, in weight of charge and projectile, muzzle velocity and initial pressure on the gun. He thought, moreover, that there was an element of safety and strength in the old cast-iron gun that was lacking in mild steel. That while cast-iron had a low limit of elasticity it would bear very high compressive strains and transmit such strains without flow of metal. Mild steel on the other hand met the limit of resistance to this flow at 40,000 lbs. pressure, and pressures of more than 30,000 lbs. were now applied to guns, with a rapid tendency to increase this pressure in practice. The speaker illustrated this theory by describing some experiments at the Watertown Arsenal where the wax test was applied to two similar cylinders, one wholly of cast-iron and the other having a portion of the cast iron replaced by a lining, ⅝-in. thick, of wrought iron; the latter burst first, though it would seem to have had in it the stronger combination of metals. The explanation was that the wrought-iron commenced to flow under the pressure applied and assisted the wax in bursting the outer shell of cast-iron instead of strengthening it. Mr. EMERY described the process of drawing down steel bars by machine hammering and testified to the good qualities of this steel, and for his ideal gun only asked for a piece of metal of similar quality 4 ft. square and about 40 ft. long. But he did not expect to live long enough to see such a mass made equal in quality to the smaller sections first referred to. He thought therefore to insure the best material and perfect homogeneousness, we must depend upon built-up guns made from comparatively small parts. He referred to the good work done by exceptionally hard steel 6-in. pins used in his testing machine, which have stood for years the severest shocks and strains, such as would result from the breaking of a test-bar with 750,000 lbs. stress upon it recoiling against this pin over a ¾-in. space. Mr. THEO. COOPER and Mr. EMERY has some debate as to the relative resisting powers of a single and a double or hooped cylinder.

Mr. JOS. M. KNAPP agreed with Mr. METCALF that the best heavy gun of the future will be that known as the steel-cast gun; for smaller guns, 8 in. and less, he thought present experience abroad was sufficient to warrant our efforts in the direction of built-up guns. He thought that nothing but practice, and careful experiment would decide the endurance, and reliability of heavy cast guns; he thought that Congress should appropriate a sufficient sum for the construction of a steel-cast gun of say, 12 in. calibre, and 50 tons weight with about 1,000 lbs. projectile; the necessary plant was already available in private establishments, requiring but a comparatively trifling addition for heavy hammers, etc. The speaker closed with a compliment to the army and navy officers for the high standard of efficiency obtained by them in guns, with the small appropriations at their command.

Mr. DORSEY requested Lieut. JAQUES to give to the Society the results of his investigations into the actual work done by the ARMSTRONG wire-wound gun." Lieut. JAQUES acknowledged that a gun of this description of 9.4 in. calibre, with from 200 to 330 lbs. of powder, and a comparatively light projectile had given a record of 2,200 to 2,520 ft. per second muzzle velocity; but as to the saving in weight for same power, referred to by Mr. DORSEY, he believed that in a very few months we would see a built-up gun which would be its peer in all practical respects: for the wire-wound gun was simply an enormously costly experimental machine, although

it had stood successfully many rounds of high power; he was not aware that this wire gun was unprotected by patents, and required a very inexpensive plant to construct, and had hence been suppressed because it was open to the world.

Mr. THEO. COOPER said that with regard to material, he believed in high steel from considerations of strains only. But for structural purposes, he preferred soft steel simply for its greater element of safety. At the St. Louis Bridge, his early experience was with steel of 150,000 lbs. tensile strength, and while its use there was successful it was enormously costly, and much had been rejected. High steel was not therefore objectionable, but from its character was subject to many risks in its manipulation. Stretch in steel was of no avail in guns, for there practically any stretch meant destruction. The ideal gun would be made of material having high tensile strength, free from injurious internal strains and thoroughly homogeneous in its character. He believed that when we once get through the experimental stage, which the Government, and not individuals should pay for, that steel-cast guns could be made superior to the best European built guns. The speaker ridiculed the late appropriation of $25,000 for three 6 in. cast guns of steel, and suggested that the testing alone, would about consume that sum. Mr. COOPER in discussing the bursting effect in guns, called the attention of Members to the interesting arrangement of the lines of flow, or stress lines in passing from the bore to the exterior of the gun barrel; the author had already addressed the Society on this subject in a paper on the effect of punching steel, and the same lines had been afterwards noticed by a Russian engineer (see ENGINEERING NEWS, Dec. 13, 1884). These curved lines cross each other at an angle of about 45°, and are so well defined under stress, that they can be etched and printed from. Mr. COOPER thought it was much more reasonable to expect a greater resistance to stress from a solid barrel, than one made of hoops or tubes, when the direction and effect of these lines were considered. Prof. RANKINE had also demonstrated mathematically that these two series of curved lines, one of tension and the other of compression, were requisite to the proper interpretation of bursting effects in similar cylinders or plates. Prof. DE VOLSON WOOD, briefly remarked upon the relative action of a bursting charge upon solid and built up cylinders.

The reading of an illustrated paper on the properties of steel, by Mr. JOHN COFFIN, was commenced by request, but was discontinued owing to the lateness of the hour, and the character of the paper being such that it required study to be appreciated.

Mr. METCALF in summing up upon the discussion of his paper, for the evening, expressed some disappointment at the gun-ward tendency of this discussion. The author stated that he had long ago practically lost his direct interest in gun-making, and in his paper intended to call more especial attention to certain properties in steel and its better manipulation for the peaceful arts. His paper had been written for engineers, to show them that steel was useful and safe, but required the greatest care in its manufacture and handling. In regard to the extended remarks upon cement carbons, hardening carbons, carbides, etc., contained in the papers brought out by the original subject of his own paper, he thought the Scotch verdict of "not proven" would well apply. The susceptibility of steel to marked changes of dimensions and condition under heat application, he thought was very important in considering the gun question; and from actual experiments in this direction, he would ask what would become of the elaborately figured strains in the shrunk-on hoops of built-up guns when subjected to this heating action from the powder gases.

Written discussion were presented by the following gentlemen:—Lt. Com. F. M. BARBER, U. S. N.; Mr. JOHN COFFIN, Cambria Iron Works; Dr. R. J. GATLING; Commander C. F. GOODRICH, U.S. N.; Mr. HENRY M. HOWE, of Boston, Mass.; Lieut. W. H. JAQUES, U. S. N.; Lieut. ARTHUR M. KNIGHT, U. S. N.; Prof. JOHN W. LANGLEY; D. L. WHITTEMORE, Lieut. R. R. INGERSOLL, U. S. N.; WM. SELLARS; M. J. BECKER; L. L. BUCK; W. H. BURR; A. GOTTLIEB; A. G. HUNT; C. A. MARSHALL; P. ROBERTS, Jr.; JOSEPH M. WILSON, and SAM. TOBIAS WAGNER. Of these, the only papers read were those of Lieut. JAQUES and Dr. RICH. J. GATLING.

The following gentlemen were declared elected to membership:—

FOR MEMBERS.

HORACE ANDREWS, (Sheffield Sci. School 1872,) formerly engaged on Hydrographical and Topographical Work on resurvey of New Haven Harbor; in charge of party on U. S. Coast Survey, region of New Haven; on U. S. Coast Survey in Florida; recently Sanitary Engineer New York State Board of Health; now City Engineer and Surveyor of Albany, N. Y., and engaged on New York State Survey.

FRANK GRAEF DARLINGTON, (Mass. Inst. Tech. 1881). (Elected Junior Feb. 6, 1884,) formerly Engineer Maintenance of Way, Pittsburg, Cincinnati and St. Louis Ry., Engineer Maintenance of Way, P. C. and St. L. Division; Pittsburg, Cincinnati and St. Louis Ry.; recently Superintendent Muskingum Valley Division P. C. and St. L. Ry.; now Superintendent Cincinnati and Muskingum Ry, Zanesville, Ohio.

JOSEPH THOMPSON DODGE, (Univ. Vermont 1845,) formerly Assistant Engineer Vermont Central R. R.; Assistant County Engineer, St. Louis County, Mo.; Engineer Illinois Coal Co.; Assistant Engineer afterwards Resident Engineer Milwaukee and Mississippi R. R.; principal Assistant Engineer Minnesota Central Ry.; Chief Engineer Chicago and St. Paul Ry.; Chief Engineer Construction St. Paul, Minneapolis and Manitoba Ry.; recently Engineer Yellowstone and Rocky Mountain Divisions Northern Pacific R. R.; now Chief Engineer Montana Central Ry.; Helena, Montana.

EDWARD ADOLPH HERMANN, (Rens. Pol. 1879,) formerly Assistant Engineer Grand Tower Mining, Manufacturing and Transportation Co., Grand Tower, Ill.; engaged in Bridge Department, City Engineer's office of St. Louis; Assistant Engineer Lake Erie and Western Ry.; recently Assistant Engineer Pittsburg, Ft. Wayne and Chicago Ry.; now Assistant Engineer Cincinnati Indianapolis, St. Louis and Chicago Ry.; Indianapolis, Ind.

HENRY CLAY JENNINGS (Rens. Pol. 1879,) formerly engaged with Edge Moor Iron Co.; Assistant Engineer Maintenance of Way Pennsylvania R. R.; now Assistant Engineer, Chicago, Milwaukee and St. Paul Ry., Milwaukee, Wis.

SAMUEL FISHER MORRIS, formerly Assistant Engineer Philadelphia and Reading R. R.; Topographer Jersey Shore, Pine Creek and Buffalo R. R.; Civil and Mining Engineer in Virginia and West Virginia; Assistant Engineer Richmond and Allegheny R. R.; recently Engineer in charge Construction of Dams and Reservoirs Philadelphia and Reading R. R.; now Assistant Engineer in charge Section 9, New Croton Aqueduct, Yonkers, N. Y.

BENJAMIN FRANKLIN THOMAS, (National Normal Univ. Lebanon, Ohio,) formerly Assistant County Engineer, Lawrence Co., Ohio; Assistant Engineer Construction and afterwards Chief Engineer Chattaroi Ry.; now U. S. Assistant Engineer in charge Big Sandy River, Louisa, Ky.

FOR JUNIORS.

GEORGE MCGREW FARLEY, formerly on Allegheny Valley R. R.; on EDGAR THOMPSON BLAST FURNACE; on Pittsburg, Ft. Wayne and Chicago R. R.; now Engineer Maintenance of Way Northwestern Ohio R. R., Toledo, Ohio.

GIDEON FREDERICK HAYNES, formerly in City Engineer's office, Somerville, Mass.; on Railroads in Brazil; on U. S. Coast Survey; on Water-Works in Brazil; now Advisory Engineer Mills of William Roberts, Assoc. Am. Soc. C. E., Waltham, Mass.

CONSTRUCTION NEWS.

Water.

Irrigation.—The Berthoud Ditch, Reservoir & Water Co. has been organized at Berthoud, Col., by F. IRVING DAVIS and others; capital stock, $12,000.——At El Paso, Tex., a company has been organized by Mr. ENNIS to construct an irrigation canal.

Portsmouth, Va.—C. D. WARD, of Jersey City, N. J., has purchased the water-works, which were sold at auction on March 31, for $81,150, in the interest of a committee of the first mortgage bondholders. The works will now be pushed to completion.

Waterville, Me.—The town has voted to contract with the Waterville Water Co. for a water supply. The contract provides for ten hydrants at $50 each, additional ones to the number of 65 at the same rate, and beyond 65 at $35 each. The company proposes to take the supply from the Messalonskee stream or the Kennebec river; the former will probably be decided on. President SEWALL and Manager TUCKER, of the Maine Central R. R. Co., are interested in the water company.

Syracuse, N. Y.—A report has been made by HOWARD SOULE and W. H. H. GERE, upon the proposed plan for a water supply from the Salmon river; they examined the plans and estimates at the request of the Mayor. They report that the design for the dam is unsafe, not being of sufficient strength and that it could not be built for the amount of the estimate; no allowances made in the estimate for coffer dams, or for securing a water tight and firm foundation. The Salmon river project has received a set back, according to the Syracuse *Standard*, the Common Council having voted a refusal to take from the table the resolution requesting action at Albany on the Salmon river bill; this practically kills the resolution.

Hartford, Conn.—The Water Commissioners have submitted their report for the year ending March 1, 1887, being the thirty-third annual report. The cement-lined, sheet-iron pipes are being taken up and replaced with cast iron as fast as possible. Work was started on the Farmington (No. 4) reservoir. During the year 13,439 ft. of 4, 6, 8 and 20-in. pipe were laid, 11 hydrants and 22 gates set; there are now in use 465 hydrants, 724 gates and 295 meters. Accompanying the report are tables of receipts for water rents, cost of each department of the works for each year from 1857 to 1886, capacity of the reservoirs and rainfall. EZRA CLARK is President and Superintendent.

New Brunswick, N. J.—The Water Commissioners have presented their report for 1886, being their fourteenth annual report. The water supply has been ample and continuous and during the 14 years there has been no failure in the supply; the water is pure and wholesome, and the musty taste or smell experienced in the summer is only noticed for a few days. A comparative table of consumption, expenses and receipts for each year from 1880 to 1886 is given. The engines are in good order, and the reservoirs have been cleaned and repaired. During the year 7,880.4 ft. of 4, 6 and 8-in. pipe were laid, 11 hydrants and 19 gates set; the system now comprises nearly 24 miles of pipe, 173 hydrants and 265 gates. There are 84 meters in use, Crown, Gem Worthington, Empire and Equitable. Tables of the engine record, expenses, water rents, rainfall, etc., are given. A. J. JONES, is Superintendent.

Little Rock, Ark.—The water-works are very nearly completed and the water is to be turned on April 10. The works are designed for a population of 100,000 and were commenced in February, 1886. The reservoirs are about a mile west of the city and half a mile from the Arkansas river; the water is pumped into a settling reservoir, whence it passes to the distributing reservoir and flows into the distributing mains; the basins are altogether 600 ft. long, and are 150 ft. wide at the ends and 180 ft. wide at the wall separating the two; they are built of stone quarried out of the reservoir; each basin has a capacity of 10,000,000 galls.; and the pumps have a daily capacity of 1,000,000 galls.; the present consumption of the city is about 1,000,000 galls. per day. In case of emergency water can be pumped direct into the mains. The water is wholesome and will be pure and clear after passing the settling basin. The pumping plant was made by the Blake Manufacturing Co. of Boston, and two miles of 16-in. pipe have been laid from the pumping station to the reservoirs and to the city; there are now about 16 miles of pipe, and extensions are being laid. The works will cost about $200,000; $125,000 for the reservoirs and $75,000 for the pumping plant and mains. The works were built by COL. ZEB. WARD, and the plans were approved by Col. FLAD, of St. Louis, Mo. There is great activity in real estate business in the city.

New Water Works.—Dallas, Tex. The Council has directed the Water Commissioners to at once construct a reservoir of 103,000,000 gals. capacity at Turtle creek, to cost $13,000.——Montclair, N. J. Water-works are being put in; the pipe trenches are being excavated. The supply is to be from artesian wells and is expected to be of ample quantity.——Savannah, Ga. Five artesian wells are now flowing and two more are to be put down; it is expected that the city will have the artesian supply by May; river water can be pumped into the mains when desired.——Hull, Que. The water-works system is nearly completed to form a fire service round the city, and the system will be extended through the city; about $50,000 have been expended and $60,000 more will be required.——St. Augustine, Fla. The city will issue bonds for $30,000 for water-works.——Concordia, Kan. Work has commenced on the new system, which is to cost $45,000.——Pendleton, Ore. The works are being pushed.——Kearny, N. J. The bill has been passed authorising the township to contract for water-works.——Fredonia, Kan. A franchise has been granted to John A. O'Neal; the supply will be pumped from Fall river into a reservoir 168 ft. high; there will be six miles of pipe and the pumps will have a daily capacity of 1,500,000 gals.; work is to be commenced at once.——Bellevue, O. The water-works are completed and have been tested with satisfactory results; the Bellevue Water Co. will supply Dayton.——Petrolia, Pa. The water-works have been sold to private individuals.——Claremont, N. H. Address D. W. JOHNSON.——De Land, Fla. Address FRED S. GOODRICH.——Glenwood Springs, Col. Address W. E. SHAFER, Mayor.——Mount Clemens, Mich.——Columbus, Kan.

Toledo, O.—The Trustees of the Water-Works have submitted their report for 1886, being the fourteenth annual report. An improvement in the water supply is recommended by constructing settling reservoirs, which plan has been proved to be practicable; the attention of the Council is called to the report of J. D. COOK, C. E., accompanying the Trustees report for 1885. During the year 9,272 ft. of pipe were laid, principally 4-in. and 6-in. and including 120 ft. of 30-in. force main, the total length is now 273,654 ft.; seven new hydrants have been set, making a total of 383; 15 valves and valve boxes were set. Of new meters 62 were set and 15 taken out; there are 304 now in use, Crown, 221; Worthington, 43; Union, 20; Empire, 17; Ball & Fitts, 3. The Worthington pumps, which have been in service for twelve years, have worked satisfactorily; the new Knowles pumping engine, which will be in operation next May,

will be connected with the new system of force mains. The total amount of water pumped was 1,386,395,390 gals., a daily average of 3,798,343 gals. H. C. COTTER is Superintendent.

Newburg, N. Y.—The Water Commissioners have submitted their report for the year ending March 7, 1887, being the twenty-first annual report. The water supply has been abundant, but there was much complaint during the summer, of taste and odor of the water; an election was called for an appropriation of $37,500 for the establishment of the Hyatt system of filtration, but it was rejected. The lower reservoir has been cleared, and other necessary work done; improvements were made for aerating the water, and causing the contained matter to settle. Propositions for improving the supply by carrying the water from Silver creek into the lake, are again referred to; estimates for this work have been made by CHARLES CALDWELL, C. E. The report of the Superintendent contains a full account of the work done, the improvements needed and a complete record of the condition of the works during the year; appended to it are tables of observations of the depth of water; monthly averages of rain and melted snow for a series of years, analyses of the water, water rates, etc., and the water-works ordinance. WM. C. MILLER is Secretary and Superintendent.

Lowell, Mass.—The Water Board has presented its report for 1886, being the fourteenth annual report. The Department is reported as being in excellent condition. A contract for 115 tons of pipe and specials was awarded to the Mellert Foundry & Machine Co., of Reading, Pa., at $3,209.50. The report states that 'Clerks and assistants in the office have been employed from time to time as the service requires, without regard to political results or criticism." The report made to the Board by GEORGE E. EVANS, City Engineer, contains details of the operating expenses, and tables of the engine performance, coal consumption, etc. The works are owned by the city and were built during 1870 to 1872; the supply is taken from the Merrimack river, and is pumped by one Morris and one Worthington pumping engine, of 5,000,000 gals. daily capacity each. The population is estimated at 67,000, with 65,000 supplied. The total consumption was 1,441,622,640 gals., of which 326,999,956 gals. were metered; the average daily consumption was 3,949,651. The distribution pipes are of cast-iron, from 4 ins. to 30 ins. diameter; during the year 10,813 ft. were laid, making a total length of 429,245 ft.; 13 hydrants and seven gates were set, making totals of 773 and 538 respectively. The range of pressure at center for day and night is 50 to 60 pounds. The service pipes are of lead and wrought-iron, from ¾-in. to 3 ins. diameter; 8,527 ft. were laid, making a total length of 52 miles 1,258 ft.; 241 service taps and 40 meters were added, making totals of 7,127 and 1,461 respectively. HORACE G. HOLDEN is Superintendent.

New Bedford, Mass.—The Water Board has presented its report for 1886, being the seventeenth annual report. The pumping plant is in good condition. Another source of supply is recommended. The growth of algæ made its annual appearance in July, and the disagreeable taste and odor of the water continued for about a month; the Superintendent makes some remarks upon this growth. During the year 11,448 ft. of pipe were laid, 30 hydrants and 36 stop gates set, 21 small gates and 10 private gates put in: there are now in use 52,655 miles of pipe, 388 hydrants, 509 stop gates, 51 waste gates, 57 small gates, 106 private stop gates and 33 watering cart hydrants. The works were built in 1866 to 1869 inclusive, and are owned by the city; the source is from a storage reservoir formed by a dam across the valley of the Acushnet river seven miles north of the city; the supply is by gravitation into the city, thence pumped into a distributing reservoir on an elevated site; the pumping plant consists of a McAlpine engine, built by the Quintard Iron Works, and two Worthington engines. The estimated population is 34,500, 30,351 on the lines of pipe, and 28,480 supplied; the total consumption was 1,086,534,615 gals., an average daily consumption of 2,976,807 gals.: domestic meters measured 2,055,733 gals., and manufacturers meters, 105,858,555 gals. The distribution pipes are of wrought-iron cement-lined and cast iron, from 4 ins. to 30 ins. diameter; the range of pressure at center for day and night is 25 to 36 pounds; the service pipes are of lead and cast-iron, from ¾-in. to 8 in. diameter; total length about 30 miles; there are in use 45 domestic and 37 manufacturers meters, also 26 motors and elevators. The report is very full and complete and contains valuable and interesting information; the Superintendent's report presents a complete showing of the works for the whole year. Accompanying the report are illustrations of the Worthington high duty engine and the report on its tests, a diagram of the consumption, etc., for ten years; also tables of consumption, pressure, comparisons with other cities, rainfall, engine performance, etc. ROBERT C. P. COGGESHALL is Superintendent.

Montreal, Canada.—The City Surveyor, Mr. ST. GEORGE, has submitted his annual report. He recommends that the city work its own quarries as the contractors work them without any system, and are destroying their value. The cost of street cleaning was $26,400, and watering, $14,618; the watering consumed 36,238,400 gallons; 8,000 yds. of sewers were built, making a total of 26,610 yds. The snowfall was light, January 17.4 ins., February 10.3, March 26.5, April 2.8, and December 22.4, total, 79.4 ins.

The Water Superintendent Mr. LESAGE, has also submitted his report. During the year 34,886 ft. of pipe were laid, 42 hydrants put in and 1,326 new connections made. The system now includes 144.5 miles of mains, 1,196 stop valves, and 945 fire hydrants (52 of which are private). There are 29,981 houses supplied. The total amount pumped was 4,614,679,249 gallons, a daily average of 12,647,000. The report concludes by referring to the laying of the new 24-in. pipe for fire purposes, and speaks in favor of the idea suggested by Mr. PERRY and Mr. KEEFER, C. E., for carrying out a special system for fire service.

Water Motors.—MR. J. T. RODDA, of Eastbourne, England, sends us copies of two papers by him on the extended use of water motors, published in the "Journal of Gas Lighting." He points out the superiority of turbines, but shows that while far more efficient than other forms of motors they are difficult to construct, and that departures from the mathematical principles of design are followed by worse results than those given by vertical, breast and undershot wheels. Much power is also lost from want of consideration as to the proper size of the flumes, wheel-pits, races, etc. Pressure and impulse turbines are described. Of American turbines he mentions Mr. John Turnbull's "Hercules," for which he says an efficiency of 80 per cent. may be relied on. He states that this machinery so readily converts the force of falling water into a form which can be conveniently transmitted to a distance that there are many water powers now running to waste which will be utilized.

With these papers Mr. RODDA sends a description of his Water Meter History Register Book, which is intended for the use of engineers and others having to use meters, and in which are entered all data as to maker, cost, repairs, efficiency by test, etc. It consists of a ruled book, with printed headings, adapted for keeping a complete record of every meter used.

Galveston, Tex.—The City Engineer, H. T. WILSON, has submitted his annual report to the City Council. On the subject of water supply he recommends that the system of driven wells be given a careful consideration; he refers to the work of this kind done by W. D. Andrews & Bros., of New York, for Brooklyn, N. Y., consisting of a series of 2-in. tubes driven into the ground in pairs 18 ft. apart; between the two lines of wells is the collecting main which is connected to each well. As to the harbor improvements, Mr. WILSON states that something must be done to maintain the importance of the port; either by dredging out the bar or by more rapidly carrying out the government work; meanwhile he advises that dredging can do no harm and should be started. To prevent flooding there are only two remedies, either to build a seawall along the east and south ends of the city (a plan for which is submitted) or to raise the city to a height above any storm water by filling, leaving channels and outlets for proper drainage. If neither of these plans is adopted, the next best thing is to complete the jetties or groins, now existing on the beach, by building them higher, extending them 250 ft. further seaward, and adding others further west where ercsion is taking place. It is stated that the principle of groins extending at right angles to the coast line is correct and that the present ones would have proved effective had they been higher and longer. It is suggested that the sand on the beach be used for making concrete blocks, which would be sunk in a "quasi liquid" condition. These groins would prevent rapid erosion, but would not be a preventative against storm water.

Proposals Open.

Railroad Grading.—Good drag scraper work, from McCracken 125 miles west; Colorado extension of the Missouri Pacific R. R. Sub-contracts to let. J. B. COLT & SONS, McCracken, Kan.

Railroad.—M. WILLIAMSON, President, Chattanooga & Southwestern R. R., Chattanooga, Tenn.

Steam Roller.—Steam road roller, between ten and twelve tons. WILLIAM LUDLOW, Engineer Commissioner, Washington, D. C. April 11

Laying Water Pipe.—Trenching and laying water pipe. THOS. J. NEVILLE, Clerk of Executive Board, Rochester, N. Y. April 11.

Sewers.—Ten miles of brick and pipe sewers. EDWARD RUMMEL, Supervisor, Lake View, Ill. April 11.

Laying Water Pipe.—Laying five miles of 4, 6, and 8-in. pipe. EDWARD RUMMEL, (*as above*). April 11.

Street Improvement.—Grading, curbing and cedar block paving. EDWARD RUMMEL, (*as above*). April 11.

City Work.—Broken stone, 24-in. tile sewer, cobblestone paving, sprinkling, etc.; separate bids. H. W. BANNISTER, City Clerk, Syracuse, N. Y. April 11.

Bulkhead.—Stone and timber bulkhead in city dock. N. H. HUTTON, Engineer of the Harbor Board, Baltimore, Md. April 12.

Paving.—Cobblestone paving with top asphalt dressing, according to the City Engineer's plans. THE BOARD OF PUBLIC WORKS, Providence, R. I. April 13.

Culvert.—Arch culvert: about 450 perches of masonry. Plans at office of WM. H. SHIPLEY, Bridge Superintendent, Morse Building, Baltimore. COMMISSIONERS FOR BALTIMORE COUNTY, Towsontown, Md. April 13.

Railroad.—Grading, trestling, drainage, cross-ties and tracklaying of five-mile sections from Danville, Tenn., to La Grange Furnace, Stewart county. LA GRANGE FURNACE CO., Berry Block, Nashville, Tenn. April 15.

Excavation.—For cellars and for concrete foundations: separate bids. CONGRESSIONAL LIBRARY COMMITTEE, 145 East Capitol street, Washington, D. C. April 15.

Street Grading.—J. EARNSHAW, C. E., Fourth & Race streets, Cincinnati, O. April 16.

Water Pipe, Hydrants, Etc.—Three hydrants and connections, one 6-in. cut-off, 1,500 ft. of 6-in. cast-iron pipe, 674 ft. of 4-in. pipe; also pipe laying. BOARD OF WATER-WORKS TRUSTEES, Union City, Ind. April 16.

Building.—Erection and completion of the new Gansevoort market. COMMISSIONER OF PUBLIC WORKS, 31 Chambers street, New York City. April 18.

Street Work.—Sand for road surfacing, 1,200 cu. yds.; repairing sidewalk. COMMISSIONER OF PUBLIC WORKS, (*as above*). April 18.

Street Work and Sewer.—Regulating, grading, curbing and flagging; sewer. COMMISSIONER OF PUBLIC WORKS, (*as above*). April 18.

Street Cleaning.—BOARD OF CONTRACT & APPORTIONMENT, Albany, N. Y. April 18.

Sewers.—DEPARTMENT OF CITY WORKS, Municipal Building, Brooklyn, N. Y. April 19.

Curbing, Gravel and Stone.—Curbing, 700 lin. ft.; 5,000 cu. yds. double screened Roa Hook gravel; 5,425 cu. yds. 2½-in. broken trap-rock stone; 2,575 cu. yds. trap-rock screenings. THE PARK COMMISSION, Department of Public Parks, 49-51 Chambers street, New York City. April 20.

Building—Three-story and basement brick building; Architects, BRUCE & MORGAN, Atlanta. THE COMMISSION ON SCHOOL OF TECHNOLOGY, Atlanta, Ga. April 21.

Water-Works.—For supplying the agency buildings. J. F. KINNEY, U. S. Indian Agent, Greenwood, Dak. April 21.

Abutments.—For bridge at Wood Island Park, East Boston; plans at the office of the City Engineer. THE PARK COMMISSIONERS, 87 Milk street, Boston, Mass. April 22.

New Croton Aqueduct.—Additional shaft No. 13½, on Section 7. THE AQUEDUCT COMMISSIONERS, Stewart Building, New York City. April 22.

Bridge.—Span 108 ft. H. M. HAMMETT, Marietta, Ga. April 23.

Bridge.—Wagon bridge over Loup river south of Genoa, similar to bridge at Fullerton; 1,275 ft. long, 12 ft. wide; spans of 70 ft., with two turnouts, heavy oak piling for piers, ice breaks at each pier; bidders to submit plans and specifications. A. M. SCHUMAKER, County Clerk, Fullerton, Neb. April 23.

Dredging.—Dredging, removing stumps and sunken logs and overhanging trees; for improving Buffalo bayou, Tex. Maj. O. A. ERNST, U. S. Engineer Office, Galveston, Tex. April 23.

Breakwater.—At Oswego, N. Y., Capt. CARL F. PALFREY, U. S. Engineer Office, Oswego, N. Y. April 25.

Dredge Boat.—For Chattanooga; hull 75 ft. by 26 ft. by 6 ft. Lieut. Col. J. W. BARLOW, U. S. Engineer Office, Chattanooga, Tenn. April 27.

Indian Supplies.—L. VANKOUGHNET, Department of Indian Affairs, Ottawa, Canada. April 30.

Bridge.—Wrought-iron highway bridge over Republican river, three Pratt truss spans of 120 ft. each, 16 ft. roadway; tubular piers, 42 ins. diameter, ¾-in. thick; two intermediate piers of masonry; separate bids for superstructure, iron in substructure and masonry in substructure. CHARLES GUST, Chairman of Bridge Committee, Red Cloud, Neb. April 30.

Contracting.

Bridge.—The proposals for rebuilding the bridge over Pequea creek, received by the County Commissioners, Lancaster, Pa., ranged from $645 to $1,775.

The Clayton Air Compressor Works, of 33 Dey street, New York City, have leased the York street arch of the Brooklyn bridge for a warehouse for the storage of their stock of larger sizes of air compressors, as the pressure of orders at the works requires all the available floor space.

Water-Works Supplies.—At Rochester, N. Y., the Executive Board has awarded contracts as follows: Corporation cocks, J. R. Colman; 1-in., $21 per doz.; ¾-in., $15.75; ¾-in., $10.25; ½-in., $7.50. Hauling water pipe, Thos. Holahan, 81 cts. per ton. Air valves and stop-gate stones, Wall & Giedhill, $2 per stone.

Street Work.—At Kansas City, Mo., City Engineer JOHN DONNELLY has awarded contracts at the following prices: Grading: earth, 19¾ cts. per cu. yd., rock 60 cts. Stone sidewalks, 4-in. stone on ground, 38 cts.; 6-in. stone over areas, 50 and 59 cts.; supporting beams, 2¼ and 3 cts. per pound. The contract for curbing was not awarded, owing to insufficient advertising.

Sewers.—At Newark, N. J., the Committee on Sewers and Drainage has awarded contracts as follows: Hughes & Flynn; on Littleton avenue, 12-in. pipe, $1.15; basin, $135; manholes, $33; South Sixth street, $1.15, $115, $33; South Seventh street, $1.20, $115, $35; First street, 15-in. pipe, $1.35; manholes, $33. James Conway; Livingston street; 12-in. pipe, $1.21, $120, $37; Bank street, $1.16, $120, $35. ERNEST ADAM is City Surveyor.

Street Work—At Cincinnati, O., the contract for the improvement of the Madisonville pike has been awarded to Calvin H. Crane; broken stone, $1.75 per cu. yd.; crushed bowlders, $3.50 per cu. yd.; crossings, 70 cts. per ft.; curbs, 70 cts. per ft.; 12, 15 and 24-in. drain pipe, $1, $1.50 $2.50 per ft.; drain excavation, 40 cts. per cu. yd.; gutters, $1 per ft.; flag gutters, 70 cts. per ft.; grading, 33 cts. per ft.; uncoursed masonry, $5 per cu. yd.; rolling, 5 cts. per sq. yd.; gravel, $2 per cu. yd.; inlets, $10. Total, $82,770.95.

Bridge.—The following proposals have been received by Jos. H. BRUSO, Chairman of Bridge Committee, St. Clair, Mich., for an iron bridge over Pine river in that city: Mt. Vernon Bridge Co., Mt. Vernon, O., $5,600; P. E. Lane, Chicago, $5,600; Penn Bridge Co., Beaver Falls, Pa., $5,625; Smith Bridge Co., Toledo, O., $5,995; King Iron Bridge & Manufacturing Co., Cleveland, O., $6,200; Massillon Bridge Co., Massillon, O., $6,500; Wrought-Iron Bridge Co., Canton, O., $6,640. The contract was awarded to the Mount Vernon Bridge Co.

City Contracts.—The following is a list of awards made up to the end of March by the Board of Public Works, St. Paul, Minn.: Wood sidewalks for 1887: James Forrestal, $39,845.——Stone sidewalks for 1887; Lauer Bros., Berea stone, $17,250; Kettle River, $17,500; Bedford, $19,250.——Asphalt paving; Warren-Scharf Asphalt Paving Co., New York, $79,400, $11,620, $31,125, $30,-270.——Cedar block paving; S. P. Folsom, Jr., $19,590, $11,560, $19,000, $11,550, $12,200; J. H. Fielding, $14,400, $25,390,——Grading; Beyer & Lux, $7,191.75; J. T. Million, $993; Wm. Lockwood, $1,044; W. J. Murnane, $7,790.65; P. H. Thornton, $12,895.——Sewers; W. J. Preston, $954; Patrick Doherty, $1,497; $819, $2,353; $337; $5,-134; $433. Stockton & Lindquist, $10,700, $2,100; White & Adams, $1,620; Hans Hanson, $1,520; Jas. Hanson, $695. ——Grading and sewering, P. H. Thornton, $28,300. Total amount of contracts awarded, $460,344.40.

The Monroe St. Intercepting Sewer in Memphis, Tenn., completed last January, presented unusual difficulties according to the official report of Mr. NILES MERRIWETHER, the Taxing District Engineer. This sewer was built to relieve the excessive tax upon the east and west mains of the original system; it discharges directly into a bayou. The length is 3,646 ft., and the diameter is small, being 24 in. iron pipe where it crosses the Bayou Gayosa, and the main part 24 in. double-strength clay pipe laid on a concrete bed, and sunk to half its depth in similar material. The difficult work lay in running a tunnel of such small dimensions through the worst possible material, this being sandy loam, silt, sandy clay and red moulders-sand. The deepest part of the tunnel was about 45 ft. beneath the street surface, (the average depth 22 ft.) and work was carried on from shafts about 400 ft. apart. The progress was slow, tedious and expensive; the average cost material and labor being $5.78 per lin ft. of complete tunnel. The tunnel was timbered throughout with 3-set bracing, 3 × 12 in. sides and 2 × 12 in. cap with a 2 × 8 in. strut under the cap; as driven, the tunnel was about 6 ft. high, and 2 ft. 8 in. wide at top by 4 ft. at the bottom. The open cut portions were 3 ft. 6 in. wide, with 2 × 8 in. sheeting braced by 3 × 12 in. plank every 3½ ft. vertically, and 4 ft. longitudinally, the walling pieces being 3 × 12 in. The 24 in. clay pipe used was in 2 ft. laid lengths, and was 2 in. thick. The total cost of sewer complete was $18,738.91.

Bridge Contracts.—The King Iron Bridge & Manufacturing Co. has been awarded the contract for the Ilchester bridge, Baltimore county, Md. (*See* ENGINEERING NEWS, p. 226).——The company has also been awarded the contract for the Twentieth avenue bridge at Minneapolis, Minn. (*See* ENGINEERING NEWS, p. 211).

The Keystone Bridge Co., Pittsburg, Pa., has been awarded the contract for two iron bridges, 125 ft. between end pins, over Choctaw and Cedar creeks on the Sherman branch of the St. Louis, Arkansas & Texas R. R.; J. F. HINCKLEY, Chief Engineer.

The Pacific Bridge Co., San Francisco, Cal., has been awarded the contract for a bridge across the Salina river at Templeton; three spans of 110 ft. on iron piers filled with concrete.

The Mount Vernon Bridge Co., Mount Vernon, O., has been awarded the contract for the aqueduct bridge between Georgetown and Washington, D. C. (*See* ENGINEERING NEWS, p. 195). There will be nine deck spans of 114 ft., one viaduct span of 127 ft. over the canal, and one double intersection truss of 160 ft. span.

The Penn Bridge Co., Beaver Falls, Pa., is putting up an iron bridge for the Savannah & Tybee R. R. across Augustine creek.

Dredging.—The following proposals were opened April 6, by LIEUT. COL. WALTER MCFARLAND, U. S. Engineer Office, New York City, for improving Newtown creek, New York: Atlas Dredging Co., Wilmington, Del.: 70,000 cu. yds. below Maspeth avenue, 49.7 cts., $34,790; 60,000 cu. yds. above Maspeth avenue, 39.7 cts., $23,820. Morris & Cummings Dredging Co., New York City; 48 cts., $33,600; 35 cts., $21,000. Thomas Potter, Jersey City, N. J.; above Maspeth avenue, 33⅓ cts. $20,000.

Railroad Contracts.—A. A. Grant, of Pueblo, Col., and Albuquerque, N. M.; Barney Lantry & Sons, and James Parker, of Kansas City, Mo., have contracts for the construction of the Denver & Santa Fé R. R.

J. G. Mengies, of New York, has taken the contract for the construction of the Drum Point R. R., from Baltimore, Md., to Drum Point, 72 miles.

Macdonald & Cameron, have been awarded the contract for extending the Fayetteville branch of the St. Louis & San Francisco R. R. from Powell to St. Paul, Ark.

Shillman & Moore, New Lisbon, O., have the contract for the construction of the Pittsburg, Marion & Chicago R. R.

Frost, Sterne & Co., of Columbus, O., have been awarded a contract for $175,000 for a stretch of road to improve the Eastern division of the Cincinnati, Indianapolis, St. Louis & Chicago. R. R.

A. S. and Frank Everest, of Atchison, Kan. (for T. J. Prosser & Co.) have a contract for nine miles of road from Warwick, Kan., on the Missouri Pacific R. R., to Superior, Neb., on the Burlington & Missouri River R. R.; it is in the Missouri Pacific interest.

McNeely & Robinson have been awarded another contract for grading 100 miles of the Chicago, Kansas & Nebraska R. R.; this will carry the line into the Indian Territory.

Mason, Hoge & Co., of Frankfort, Ky., have been awarded contracts for building the Huntington line from Ashland to Newport, Ky., also for grading the Pineville extension of the Louisville & Nashville R. R., and the West Point & Stephensport section of the Louisville, St. Louis & Texas R. R.

It is reported from Santa Rosa, Cal., that contractor Waltz has refused to carry out his contract for the construction of the Santa Rosa & Benicia R. R. and the contract will be relet.

The Georgia Improvement Co., which has the contract for the construction of the Atlanta & Hawkinsville R. R., has organized with H. T. INMAN, President; J. K. BRUNNER, Secretary, and H. C. HARRIS, manager.

The Panhandle Construction Co., M. FELSENHELD, Vice-President, which has the contract for the extension of the Fort Worth & Denver R. R. to the Colorado river, reports 200 miles completed from Fort Worth, Tex.

John Broderick has been awarded the contract for the construction of the dummy line from Nashville, Tenn., to the property of the Waverly Land Co.

Larson, Keefe & Co., of Helena, Mont., have been awarded the contract for the construction of the Montana Central R. R. from Helena to Butte, 88 miles: the contract including the entire work; there were 66 bidders and 135 separate bids for the work. There will be one tunnel 6,000 ft. long. The work will amount to over $1,300,000. This firm also has the contract for the construction of the Helena & Northern branch of the Northern Pacific R. R.

Railroads, Bridges and Canals.

Chicago & Indiana Coal R. R.—The company has purchased the Chicago & Eastern Illinois R. R., by which it gets a through line to Chicago and good terminal facilities in that city, and also becomes independent of the Louisville, New Albany & Chicago R. R., by which line it formerly reached Chicago. The Chicago & Eastern Illinois R. R. runs from Chicago to Terre Haute, Ind., 178 miles, but it owns and controls 246½ miles. The capital stock of the C. & E. I. R. R. Co. is $3,000,000; H. H. PORTER, of Chicago, will be President.

A Railroad Dispute.—The Grand Trunk R. R. Co. having failed to proceed with the construction of the Ontario & Sault Ste. Marie R. R. in the time fixed by the original charter, the Canadian Pacific R. R. located its lines in such a way as to interfere with the construction of the Ontario & Sault Ste. Marie line and asked the Legislature to refuse the Grand Trunk an extension of time. The agreemen arrived at provides that both lines shall be located by WALTER SHANLY, C. E., to avoid crossing as far as possible, and where a conflict of interests results, the Ontario & Sault Ste. Marie to have the precedence. The time for construction is extended to March, 1893.

Southern Pacific R. R.—The road will secure an entrance into Portland, Ore., by the purchase of the Portland & Willamette Valley R. R. The line is to be completed into Portland this year, and is to be extended from Dundee junction to Ray's, where the Willamette river will be bridged. The route to the city is not yet decided upon, but two plans and estimates have been prepared by H. HAWGOOD, Chief Engineer of the P. & W. V. R. R, and submitted to the engineer of the Southern Pacific R. R.

The Paducah & Illinois Bridge Co. has been organized at Paducah, Ky., to build a railroad bridge across the Ohio river, about 50 miles above Cairo; work is expected to be commenced this summer. The bridge will furnish crossing facilities to several lines being built towards Paducah and will form an important link between the systems of Illinois and the south. Surveys will be made at once. The following officers have been elected: President, S. R. BULLOCK, New York; Vice-President, G. C. THOMPSON, Paducah; Treasurer, E. WOLTMANN, New York; Secretary, H. H. HUSTON, Paducah; Chief Engineer, E. F. FULLER, New York.

Railroad Surveys.—Chicago, Fort Scott & Texas R. R. The engineers have reached Rich Hill, Mo., and are near Fort Scott.——Duluth, Sioux Falls & Denver R. R. Chief Engineer J. B. HASKELL has been examining the route between Flandreau, Dak., and Lake Benton.——Chicago, Jefferson City, Girard & Pacific R. R. The survey has been completed from Girard, Kan., to Jefferson City, Mo.——Ohio Valley R. R. Chief Engineer C. W. BAYDEN has located the line between Princeton and Clarksville, Ky.——Little Rock & Eastern R. R. The survey has been completed 50 miles northwest from Altheimer, Ark.——Old Colony R. R. A line has been surveyed from Matfield to Easton.——Chattanooga, Cleveland, Ducktown & Murphy R. R. The survey has been started for this line from Chattanooga, Tenn., to Murphy, N. C.——Missouri Pacific R. R. Two parties are in the field locating a line from Fort Smith, Ark., to Gurdon, about 180 miles; construction will begin shortly.——St. Louis & San Francisco R. R. A line is being located from Hackett City, Ark., to Little Rock; construction will be begun at once.——Charleston, Cincinnati & Chicago R. R. The line has been located from Yorkville to Rock Hill, S. C.——Rocky Forks & Cooke City R. R. The survey for this Montana line has been started by Engineer KNOWLTON, of St. Paul, Minn.: the line will be completed 45 miles to the coal fields by September.——Georgia, Carolina & Northern R. R. The surveys are being made from the Savannah river to Elberton, Ga., and the location from Monroe N. C., to Chester, 45 miles.——St. John's River, Lake Weir & Gulf R. R. Surveys are being made from Norwalk, Fla., to Anclote, 120 miles.——St. Louis, Kansas City & Colorado R. R. The survey has been completed from Sedalia to Lexington, Mo.——Cincinnati, Wabash & Michigan R. R. General Manager NORMAN BECKLEY, of Elkhart, Ind., will have a survey made at once for the extension from Anderson to Rushville.

Chicago, St. Paul, Minneapolis & Omaha R. R. A branch is being surveyed from Pratt, Wis., to the Gogebic district.——Atchison, Topeka & Santa Fé R. R. A survey has been made from Versailles to Sibley, Mo., under Engineer NESBER.——Savannah & Jacksonville Air Line R. R. The line has been surveyed from Brunswick, Ga., to St. Mary's.——Duluth, Red Wing & Southern R. R. The line is now located from Zumbrota, Minn., to New Richmond, Wis., and the preliminary survey has reached Albert Lea from Zumbrota: the work is in charge of Engineer DANFORTH.——Macon & Tuscaloosa R. R. Capt. H. P. FARRER is locating the line from Macon, Miss.——Oregon Railroad & Navigation Co. A line is being surveyed from Colfax into north Idaho.——A survey will be made by CHAS. SASKETT, of Astoria, Ore., for a narrow gauge line from tidewater to the falls on the Lewis and Clarke river.——The engineers have completed the surveys between Sherman Tex., and Mount Pleasant, and will survey from Corsicana to Hillsboro; the work is in charge of Capt. O. T. LYON.——A line is being located from Decatur to Columbus and Aberdeen, Miss., 130 miles.——A line is to be surveyed by J. E. UMSTEAD, C. E., of Philadelphia, from Bayview Junction, Md., on the Philadelphia, Wilmington & Baltimore R. R., to the site of the new steel works at Tivoli.——A survey is to be made for a line from Edgewood, Ore., into the eastern part of the State.

Northern Pacific R. R.—On the west side of the Stampede tunnel, on the Cascade division, the track is within a few miles of the portal. The progress on this tunnel up to March 10 and March 16 is as follows: East end, heading, 1,938 ft. and 1,983 ft.; east end, breast, 1,896 ft. and 1,940 ft.; west end, heading, 1,921 ft. and 1,961 ft.; west end, breast, 1,877 ft. and 1,926 ft. On the switchback snow is being cleared away as fast as possi-

ble; the depth of snow is stated as follows during the middle of March: east end switchback, 4.3 ft.; summit, 9.5 ft.; west end switchback, 6.8 ft.; west mountain grade, 6 ft. According to local papers the tracks cannot be connected by May 1, but may be connected during that month.

Canadian Pacific R. R.—The Minister of Finance intends asking at the approaching session of Parliament for a further grant of $10,000,000 for the Canadian Pacific R. R. The company's traffic returns are reported to be much less than during the corresponding period last year. It is expected that the road will benefit considerably from the passage of the Inter State Commerce Bill in this country. The steamship service between Port Moody, B. C., and China and Japan will commence during this or next month. The mileage now in operation is as follows: Quebec, 372; Ontario, 1,931; Manitoba, 776; Northwest Territory, 751; British Columbia, 520; total, 4,353 miles. In addition there are 192 miles under construction, of which 70 are in Quebec and 122 in Ontario.

Maine Central R. R.—Considerable improvements will be made on the section between Mattawamkeag and Vanceboro, running terms over which have been arranged between the Maine Central R. R. Co. and the International R. R. Co. to enable the latter to reach the New Brunswick R. R. system; a heavy grade beyond Mattawamkeag will be brought to the subsidy requirements of the Dominion government. This line is 55 miles long and has not been kept in good condition; the expense of the improvements will be divited equally between the two companies. In order to facilitate the running of the fast summer express trains, it is proposed to lay track tanks between Lewiston and Waterville to enable the locomotives to take water while running; if this is not done exceptionally large tenders will be attached. Between Gardiner and Augusta the road is to be double tracked.

Willmar & Sioux Falls R. R.—The location, which was commenced at Willmar, Minn., in October last, was completed at Sioux Falls, Dak., on March 30. The line runs from Willmar through Granite Falls, Hanley, Marshall and Pipestone to Sioux Falls. The distance is 146.9 miles; the maximum grade is 31.68 ft. per mile, and the maximum curvature 3°. Between Marshall and Pipestone the line passes through a range of hills overcoming a rise of nearly 700 ft. and is the first line ever located through these hills with so light a grade. The party has been out all the winter and there have been only six days when the party has not been in the field. It is expected that the line will be built at once, and when completed will be a first class line. J. M. Spicer is President and C. F. B. Haskell is Chief Engineer.

Railroad Extensions.—Philadelphia, Wilmington & Baltimore R. R. Work has been commenced on the Edge Moor cut-off and the line will be finished by August; a new line will be built to New Castle, Del.—Duluth & Manitoba R. R. The road will be extended to Yankton, Dak., this year.—Ohio & Mississippi R. R. A line will be built from Seymour to Evansville, Ind.; C. F. Bent, Cincinnati, O., Superintendent.—St. Louis Arkansas & Texas R. R. Work is to be commenced on the branch from Altheimer to Little Rock, Ark.—Arkansas Midland R. R. The road will be extended from Clarendon to Little Rock.—Mexican National R. R. The branch is being built from the depot at New Laredo to the new Rio Grande bridge at Laredo, Tex., and the new depot at Laredo is nearly completed.—Chicago & Indiana Coal R. R. A branch will be built to Rockville, Ind.—Northern Pacific R. R. The construction of an extension sixty miles long, of the Spokane & Palouse line has been ordered.—Fitchburg R. R. A line is to be built from Troy, N. Y., to the West Shore R. R. at South Schenectady.—Lake Erie & Western R. R. Work has been commenced on the extension from Bloomington to Peoria, Ill.—Atchison, Topeka & Santa Fè R. R. Several cut-offs are being built to shorten the distance between Winfield, Kan., and Kansas City; the Southern Kansas line is building an air line from Burlington to Winfield; that city will be an important center of the system and will be the headquarters of the Southern Kansas division; a line is being built from Holliday to Atchison.

Cedar Rapids & Marion R. R. The line will be extended from Marion to Central City, Ia., at a cost of $100,000; Wm. Elson, Cedar Rapids, Superintendent.—Charleston & Savannah R. R. A branch is being built from Ravenal station to Young's island, 5½ miles.—Minnesota & Northwestern R. R. Work is in progress on the extension from Freeport to Dubuque, Ia.—Cleveland, Loraine & Wheeling R. R. The extension from Bridgeport, O., to Martins Ferry, has been completed, and the extension from Bridgeport to Bellaire will now be pushed.—Chicago, Milwaukee & St. Paul R. R. The line will be extended from Madison to Huron, Dak.—Oregon Pacific R. R. Right of way has been secured for several miles east of the Santiam river, and ties have been delivered for the line.—Cincinnati, Hamilton & Dayton R. R. The Dayton & Delphos narrow gauge line has been purchased, by which right of way is obtained for an extension from Delphos to Decatur, Ind.; the Dayton & Ironton road is to be changed to standard gauge this month and the Dayton & Delphos road next month.

Indiana Midland R. R. The road is to be extended west from Lebanon, either by way of Crawfordsville, Ladoga or Rossville.—Rome, Watertown & Ogdensburg R. R. A line will be built from Wilson or Olcott to Lockport, N. Y.—Regina & Long Lake R. R. The road will be extended from Long Lake to Battleford, Manitoba; Mr. Pugsley is President.—Long Island R. R. The Mineola branch will be extended from Locust Valley to Oyster Bay and ultimately to Northport.—Atchison, Topeka & Santa Fè R. R. Work has been commenced on the line between Denver, Col., and Pueblo; there will be a branch from Pueblo to the Colorado Midland R. R.; a branch is to be built to Keokuk, Ia.—Mexican Central R. R. Work will soon be commenced on the Guadalajara branch.—Gulf, Colorado & Santa Fé R. R. Work is progressing on the Fort Worth extension.—Louisville, New Orleans & Texas R. R. The Lake Washington branch is to be extended through Sharkey county, Miss.—Illinois Central R. R. The Yazoo branch will be extended from Cruger to Glendale, Miss., 92 miles; a line will be built from Terry to Vicksburg, Miss.; the extension from Freeport, Ill., to Madison, Wis., will be completed by August; an independent line will be built between Dubuque, Ia., and Sioux City.—Boston, Hoosac Tunnel & Western R. R. A new route is proposed to avoid the Hoosac tunnel, the line will form a loop from Bardwell's Ferry, Mass., through Heartwellville, Vt., to the main line again a few miles west of North Adams.—International, Occidental & Interoceanic R. R. It is reported that construction is to be commenced again on this line from Nuevo Laredo to the City of Mexico; the line is located from Nuevo Laredo to Guerrero, Mier and Victoria, down the gulf coast to Tuxpan and along the table land to the capital; 150 miles are graded; the line is in the Gould interest.

New Railroads.—Kansas & Arkansas Valley R. R. The construction of 100 miles from Van Buren, Ark., to beyond Gibson, I. T., has been ordered.—Fort Worth Western R. R. At Fort Worth, Tex., it has been decided to bond the road for $15,000 per mile and to build at once through the coal fields in Jack and Young counties.—Wichita, Cedarvale & Fort Smith R. R. The plans have been approved and work will be commenced shortly; the line will run from Wichita, Kan., to Fort Smith, Ark., 150 miles.—Boston & Quebec Air Line R. R. The line will run from Skowhegan, Me., through Madison, Solon, Bingham and Moscow to Moose River, Me., where it will connect with the Canadian Pacific R. R.; the Quebec Central R. R. will also build to connect with the line; the route has been surveyed by A. T. Stewart, of the C. P. R. R.—Decatur & Aberdeen R. R. The right of way for this Alabama line is being secured.—Northwest Central R. R. Work on this Canadian line is expected to be commenced next month.—Broken Bow & Northern R. R. This line, in the interest of the Burlington & Missouri River R. R., will run from that line at Broken Bow, Neb., to the Chicago & Northwestern R. R. at Ainsworth, with a branch from Walworth to Ladora.—Hudson Bay R. R. As soon as the weather permits work will be started at both ends of the line.

Kansas City & Pacific R. R. Work is progressing, six miles of track have been laid; the road will be from Parsons to Kansas City.—British Columbia & Seattle R. R. Work will soon be commenced; Mr. Canfield is negotiating with the Canadian Pacific R. R.—Megantic R. R. Work will be commenced shortly on this Maine road; Wm. McKenzie is interested.—Niagara Falls & Whirlpool R. R. Land is being condemned and work will be started before summer.—Chicago, St. Paul & Kansas City R. R. All the right of way in Iowa has been secured and work commenced from Des Moines to the State line; the road will be pushed to St. Joseph, Mo.; M. C. Woodruff is Secretary and Right-of-Way Agent.—Alabama, Florida & Atlantic R. R. This is the new name for the enlarged scheme of the Apopka (Fla) & Atlantic R. R.

A railroad will be built from the Canadian Pacific R. R. at Ottawa, to James Bay; Montreal parties are interested.—A railroad is to be built from Woodstock, Ont., to Brantford and the Niagara river, and also via St. Mary's to Lake Huron.—A railroad is to be built from Colebrook, N. H., to the Grand Trunk R. R. at North Stratford.—A railroad will be built from Bangor, Me., to Milo, via Corinth, 34 miles; estimated cost $12,000 per mile; the Bangor & Piscataquis R. R. Co. is interested.—All the $70,000 stock of the railroad between Harwich and Chatham, Mass., has been taken up and work will soon be started; Hon. Marcellus Eldridge, Portsmouth, N. H., President, Charles Bassett, Chatham, Mass., Secretary.—A new railroad is to be built between Haverhill and Lawrence, Mass.—A railroad ten miles long will be built from Sour Lake, Tex., on the Southern Pacific R. R.; Frank J. Bowman, of St. Louis, and P. J. Willis, of Galveston, Tex., are interested.—A narrow gauge railroad is to be built from Boise City, Idaho, to the Oregon Short Line R. R., about 20 miles.—At Montreal a belt railroad is to be built and an elevated railroad up the mountain; F. W. Henshaw is interested.—New Albany & Eastern R. R. Work will be resumed.—A narrow gauge road is to be built between Durango and Albuquerque, N. M.

Railroad Companies.—Griffin, La Grange & Western Ry. Co.; from Birmingham, Ala., to La Grange, Griffin Ga., and the coast; President, Douglass Green, New York.—Missouri, Kansas & Nebraska R. R. Co.; from Paola, Kan., to Lawrence and northwest; Judge, S. O. Thatcher, Lawrence, Kan., and others; capital stock, $1,000,000; in the Missouri Pacific interest.—Toledo Peoria & Western Ry. Co.; from Iroquois county, Ill., to Hamilton, with a branch from La Harpe to Burlington, Ia.; Wm Hill, Warsaw, Ill., and others; capital stock, $4,500,000.—Port Elgin & Teeswater Ry. Co.; from Teeswater, Ont., to Port Elgin; M. Johnson, Port Elgin, Bruce county, Ont.—Flagstaff & Grand Cañon R. R. Co.; connecting with the Atlantic & Pacific R. R. 60 miles; work will commence next month; D. M. Riordan, Flagstaff, Arizona.—Ottawa & Thousand Islands Ry. Co.; to be commenced in three and completed in seven years; W. H Jones, Brockville, Ont.; capital stock, $1,250,000.—Sellwood & Vancouver Ry. Co.; T. A. Wood, Portland, Ore.—Little Rock & Texas R. R. Co.; from Hackett City to Pulaski county; Jas. Brizzolara, Fort Smith, Ark.; capital stock, $5,000,000.—Colorado & Wyoming R. R. Co., J. J. Taylor, Denver, Col.; capital stock, $5,000,000.—Chicago, Grand Tower & Texas R. R. Co., from Chicago to Grand Tower, Mo., and Paducah, Ky.; Jas. A. Fox, Detroit, Mich.; capital stock, $10,000,000.

Lincoln & Black Hills Ry. Co.; from Central City, Neb., to the Dakota line, with several branches; G. W. Holdrege, Lincoln, Neb.; capital stock, $5,000,000.—Tacoma Railway, Dock & Navigation Co.; railroad from Tacoma to Vancouver, Wash T.; President, Philip Melzter, Tacoma; capital stock, $100,000.—Newport, Jonesboro & St. Louis Ry. Co. from Jonesboro, Ark., to Newport, 40 miles; G. W. Decker and others, office at Newport, Ark.; capital stock, $300,000.—Harrisville, Grantsville & Charleston R. R. Co.; office at Harrisville, W. Va.—Memphis, Arkansas & Texas R. R. Co.; President, Geo. Arnold, Memphis, Tenn.; Chief Engineer, T. G. Dabney.—New York, Wheeling, St. Louis & Chicago Ry. Co.; E. C. Rice, St. Louis, Mo.; capital stock, $5,000,000.—Cincinnati, New Richmond & Ohio River R. R. Co., at Columbus, O.; Wm. P. Devon, Fred. G. Roelker and others; capital stock, $100,000.—Cincinnati & Dayton R. R. Co.; H. F. Northup, P. J. Sohl, of Middletown, O., and others; capital stock, $1,000,000.—Union Pacific & Colorado Western R. R. Co.; from Laramie, Wyo., to the Colorado Western R. R. at the State line, and on to Salt Lake City; President, Charles Francis Adams; capital stock, $6,000,000; in the Union Pacific interest.—Mexican Pacific Ry. Co.; at San Francisco, Cal.; from the city of Mexico to Cuernavaca and Puente de Ixtla, in the State of Morelos, 86 miles; Geo. Hearst; capital stock, $2,000,000.

Southern Central Ry. Co.; from Stratford, Ont., to Port Burwell, with a branch to Brantford and Paris, 53 miles; Wm. Waterworth, Ingersoll, Ont.; capital stock, $300,000.—Augusta & White River R. R.; in Arkansas, 1½ miles; capital stock, $10,000.—Vincennes Belt R. R. Co.; President, N. F. Dalton, Vincennes, Ind.; capital stock, $80,000; to be built shortly.—Tuscaloosa Northern R. R. Co.; President, H. H. Peck, Cincinnati, O.; work to be commenced at once.—Sabine River Ry. Co.; from the Houston & East Texas R. R. to the Louisiana State line, 26 miles; E. S. Hicks, E. H. Hearne and others; capital stock, $70,000.—Watertown & Lake Shore R. R. Co.; A. C. Mellette, Watertown, Dak.—Sabina, Pacific & Lincoln R. R. Co.; J. B. Hamilton, Sabina, Kan.; capital stock, $2,000,000.—Denver & Santa Fé R. R. Co.; from Denver to Golden, to Colorado Springs and Pueblo, Col., and to acquire the Denver Circle Ry.; T. E. Conduct, Denver; capital stock, $3,500,000.—Birmingham, Irondale & Ozmoor R. R. Co.; six miles; Charles Turner, Birmingham, Ala.; capital stock, $100,000.—Birmingham, La Grange & Macon R. R. Co.; John T. Milner, Montgomery, Ala.—Chattanooga Valley R. R. Co.; from West Point, Ga., to Lafayette, Ala.; L. Lanier, West Point, Ga.; capital stock, $1,000,000.

Cumberland Plateau, Obed River & Nashville Ry. Co.; from Scott county, Ala., to Nashville, Tenn.; L. T. Smith.—Louisiana, Moberly & Omaha R. R. Co.; John T. Zimmerman, Chicago; Henry B. Sage, New York.—Pierson, Kenwood & Palmetto R. R. Co.; narrow gauge; W. Grayson Mann, N. L. Pierson, Pierson, Fla.—Atlanta & Alabama Ry. Co.; from Atlanta, Ga., to Selma, Ala.; Col. R. M. Nelson, Atlanta, Ga.—Boca Grande R. R. Co.; John Cross, Pine Level, Fla.—Grand Trunk, Georgian Bay & Lake Erie Ry. Co.; application to Dominion government for extension of time and to extend the line.—Madison & Southeastern Ry. Co.; President, Wm. Cravens, Eminence, Ky.—A company is to be incorporated in Canada to build a line from Kingston to Smith's Falls and Ottawa, with branches; and with power to acquire and operate the Rideau canal; address D. A. Givens, Kingston, Ont.